ENERGY ENGINEERING ANALYSIS PROGRAM
100TH ASG
GRAFENWÖHR AND VILSECK, GERMANY

ENERGY AUDIT OF DINING FACILITIES

FINAL REPORT
AUGUST 1993

VOLUME III

APPENDICES

PREPARED FOR:

U.S. ARMY ENGINEER DISTRICT, EUROPE
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APPENDIX A

SCOPE OF WORK

CETAE-PM-ME

8 May 1992
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GENERAL SCOPE OF WORK

FOR AN

ENERGY SURVEY OF ARMY DINING FACILITIES

100th ASG

GRAFENWOEHR, GERMANY

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM

SCOPE OF WORK
FOR AN
ENERGY SURVEY OF ARMY DINING FACILITIES

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ANNEXES

1. <u>BRIEF DESCRIPTION OF WORK</u>: The Architect-Engineer (AE) shall:

1.1 Perform a complete energy audit and analysis of the dining facilities at Grafenwoehr (Bldg 101) and Vilseck (Bldg 603).

1.2 List and priortize all recommended Energy Conservation Opportunities (ECOs) identifying individual equipment for energy conservation. This list must include low cost/no cost ECOs and perform complete evaluations of ~~nine (9)~~ ECO's ~~per dinning facility~~ selected by the representatives of 100th ASG.

1.3 Prepare implementation documentation for energy conservation opportunities selected by the representatives of 100th ASG.

1.4 Prepare a comprehensive report which will document the work accomplished identifying individual equipment, the results and the recommendations on energy savings.

2. <u>GENERAL</u>

2.1 An energy study, including a detailed energy survey, shall be accomplished for the dining facilities listed in Annex B. The study shall integrate the results of, and any available data from, prior or ongoing energy conservation studies, projects, designs, or plans with work done under this contract. This Scope of Work is not intended to prescribe the details in which the studies are to be conducted or limit the AE in the exercise of his professional engineering expertise, applying the state of the art techniques, good judgment or investigative ingenuity. However, the information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study. The study shall include a comprehensive energy report documenting study methods and results.

2.2 All recommended ECOs, including maintenance, operational and low cost/no cost opportunities as well as Energy Conservation Investment Program (ECIP)/ Quick Return Investment Program (QRIP) projects shall be ranked in order of highest to lowest Savings to Investment Ratio (SIR). The installed equipment and meters shall be utilized in discussing the results.

2.3 Other studies performed under the Energy Engineering Analysis Program(EEAP) have been accomplished for the installation at which the dining facilities are located. The portions of the studies applicable to the dining facilities, if any, shall be incorporated into this study.

2.4 The AE shall ensure that all methods of energy

conservation pertaining to dining facilities, which will reduce the energy consumption of the installation in compliance with the Energy Resources Management Plan, have been considered and documented. All methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All new and updated energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunities considered infeasible shall be documented in the report with reasons for elimination. A list of general energy conservation opportunities is included as Annex A to this scope.

2.5 The study shall consider the use of all energy sources. The energy sources to be considered are electrical energy, ~~natural gas, liquefied petroleum gas,~~ and existing district heat.

2.6 The "Energy Conservation Investment Program (ECIP) Guidance," described in a letter from CEHSC-FU-M, dated 28 June 1991, establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The Tri-Service MCP Index, when updated, is contained in the latest applicable edition of the Engineer Improvement Recommendation System (EIRS) bulletin. (Revised Guidance)

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP/QRIP or OMA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this project. Upon award of this project, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this project. The EUD project manager is Mr. ~~Bhuj Gidwani~~, Ganguli (320-~~7318~~)who will serve as a point of contact and liaison for all work required under this project.

3.2 Installation Assistance. Ms. Angie Graf (475-6134/7170) at 100th ASG (Bldg 433) in Grafenwoehr will serve as the point of contact for obtaining information and assisting in establishing contacts with the proper individuals and organizations as necessary in the accomplishment of the work required under this project.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this project, except as authorized by the Contracting Officer.

3.4 Meetings. One meeting will be scheduled whenever requested by the AE or the EUD project manager for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in this meeting pertinent to the work required under this project as directed by the Contracting Officer. This meeting is in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the EUD project manager within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the EUD project manager shall conduct entry and exit interviews with the representative of 100th ASG before starting work at the installation and after completion of the field work. The EUD project manager shall schedule the interviews at least two weeks in advance.

3.7.1 Entry. The entry interview shall thoroughly describe the intended procedures for the survey and shall be conducted

prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the representative of 100th ASG.

3.7.2 Exit. The exit interview shall include a thorough briefing describing the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Dining Facility Manager.

4. <u>SERVICES AND MATERIALS</u>. All services, materials (except those specifically enumerated to be furnished by the Government), equipment, labor, superintendence and travel necessary to perform the work and render the data required under this project are included in the lump sum price of the proposed contract. Installed meters should be utilized to gather data.

5. <u>PROJECT DOCUMENTATION</u>. All energy conservation opportunities shall be included in one of the following categories and presented in the report as such:

5.1 <u>Non-ECIP Projects</u>. Projects which do not meet ECIP criteria, but which have an overall SIR greater than one shall be documented. Each project shall be analyzed to determine if it is feasible even if it does not meet ECIP criteria. These ECOs or projects may not meet the nonenergy (75%) qualification test. For projects or ECOs in this category, the life cycle cost analysis summary sheet (LCCID software), completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project and the simple payback period shall be included in the report. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition, these projects <u>may need</u> the necessary documentation prepared, in accordance with the requirements of the Government's representative, for one of the following categories:

a. Low Cost/No Cost (Self Help) Projects. These are projects which the Director of Engineering and Housing can perform with his own resources, and Self Help Program, or through the DEH Self Help Program.

b. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over $100,000 and a

simple payback period of two years or less.

c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of $100,000 or more and a simple payback period of four years or less.

The above programs are all described in detail in USAREUR Pam. 5-5, Jan. 1989. (see also ANNEX B Item (c))

5.2 <u>ECIP Projects</u>. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio greater than one and a simple payback period of less than eight years. The overall project, and each discrete part of the project, shall have a SIR greater than one. For all projects meeting the above criteria, complete programming documentation will be required. A life cycle cost analysis summary sheet shall be developed for each ECO using LCCID software and for the overall project when more than one ECO is combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effect of the individual ECOs. For projects and ECOs developed from previous studies, the backup data shall consist of copies of the original calculations and analysis, with new pages updating and revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work the project or ECO was developed under in the previous study, title(s) of the project(s), the savings to investment ratio (SIR), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. This information shall be included as part of the backup data. The purpose of this information is to provide a means to prevent duplication of projects in any future reports. In the interest of the limited resources available, only one ECIP project for each dining facility will be proposed. Furthermore the A/E may consider consolidating two QRIP projects to constitute one ECIP project.

one ECIP
EA $\geq$ 2
Facility

5.3 <u>Nonfeasible ECOs</u>. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. <u>DETAILED SCOPE OF WORK</u>. The detailed Scope of Work is contained in Annex B.

7. <u>WORK TO BE ACCOMPLISHED</u>

7.1 <u>Audit and Analysis</u>

7.1.1 Audit. The audit consists of gathering data and inspecting the dining facilities in the field. These activities shall be closely coordinated with the EUD project manager, the representative of 100th ASG (DEH) and Dining Facility Manager. The AE shall become familiar with each dining facility and undertake all necessary field trips to obtain required data. The AE shall document his field surveys on forms developed for the survey, or standard forms, and submit the completed forms as part of the report. Data sources shall be identified and assumptions clearly stated and justified. Data collected during the audit shall be in sufficient detail to identify all the major energy using equipment and processes. The AE shall measure and record the voltage and amperage of all motors one horsepower and larger. The information gathered shall be compared to the name plate data to determine whether the motor is being properly utilized. Data should be gathered when the motor is loaded. Air handling system supply, return and exhaust air quantities, temperatures, relative humidities, lighting levels, number and type of light fixtures, differential pressure readings and similar data required for the analysis shall be based on measurements made during the audit and not on "as-built" drawings. All test and/or measurement equipment shall be properly calibrated prior to its use. Operating sequences for equipment, control schedules, facility operating hours, methods of operation, and past performance records should also be obtained during the audit.

7.1.2 Analysis. The energy analysis is a comprehensive study of the dining facilities energy usage. It includes a detailed investigation of the facilities operation, its environment and its equipment. The energy analysis shall provide the following types of information: (a) a baseline of energy usage of the existing dining facility, (b) peak heating and cooling loads, (c) energy usage by systems (lighting, heating, cooling, domestic hot water, etc.), (d) a basis for evaluating ECOs, and (e) a baseline of energy usage of the dining facility after incorporation of all recommended ECOs. The AE shall develop graphic presentations in consultation with the representatives from 100th ASG and EUD representatives , i.e., selected graphs and charts, which depict a complete energy consumption picture for the dining facilities as they are now and after implementation of the recommended energy conservation opportunities and include these in the report.

7.2 <u>Identify ECOs</u>. All methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures and maintenance practices as well as the physical facilities. A list of energy conservation opportunities is included as Annex A to this scope. This list is not intended to be restrictive but only to assure

that at least these opportunities are considered, discussed and documented in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to technical and economic feasibility. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data. ~~For ECOs which would replace the existing heating, ventilating, and air conditioning (HVAC) system or significantly change it (such as converting a multizone system to a variable air volume (VAV system)) the AE is required to run a computer simulation to analyze the system and to determine the energy savings. This requirement to use computer modeling applies only to heated and air conditioned or air conditioned only buildings which exceed 8,000 square feet or heated only buildings in excess of 20,000 square feet. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex B, lists programs that are acceptable to the EUD project manager. If the AE desires to use a different program, it must be submitted for approval with a sample run, an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.~~

7.3 Prepare Implementation Documentation. For feasible projects or ECOs which do not meet ECIP criteria, implementation documentation shall be prepared. Each feasible project or ECO shall be individually packaged and fully documented and included as a separate section in the volume containing the programming documentation. Each project or ECO shall have a complete description of the changes required, economic justifications, sketches, and other backup data included as a section in the report. The documentation required will be as determined by the Government's representative. Documentation required will be in the categories listed in paragraph 5.2. For the QRIP, and PECIP

USAREUR PAMPHLET

projects, documentation shall be prepared in accordance with the requirements of UP 5-5, A sample implementation document, consisting of a DA Form 5108-R, sketches and manufacturers data and a life cycle cost analysis summary sheet shall be submitted for review and approval with the interim submittal. This sample shall be submitted and approved prior to the preparation of any other implementation documentation. To the degree possible, the project selected for the sample submission shall be typical of the majority of subsequent projects to be submitted. The sample shall consist of complete implementation documentation with primary emphasis on format and manner of presentation rather than precise accuracy of cost estimates and energy saving data. This can be deleted if not needed).

a. Brief description of the project.

b. Brief description of the reasons for the modification.

c. Specific instructions for performing the modification.

d. Estimated Deutsche Mark (Dollar) and energy savings per year.

e. Estimated manhours and labor and materials costs. Costs shall be calculated for the current calendar year and so marked. Manhours shall be listed by trade. For projects that would repair an existing system so that it will function properly, also include the estimated manhours by trade and labor and material costs necessary to maintain the system in that condition. Some of the simple practical modifications may be developed on a per unit basis. An example of this type of modification would be the repair or replacement of steam traps on an as needed basis. As a rule, however, the AE should develop complete projects, if at all possible, rather than per unit modifications.

Separate sheets for each project showing the above information shall be prepared and included in the report.

7.4 <u>List and Prioritize All Projects</u>.

7.4.1 The AE shall list and prioritize all energy conservation opportunities by savings to investment ratios.

7.4.2 The AE shall list and prioritize all projects by types of projects and savings to investment ratios.

7.5 <u>Submittals, Presentations and Reviews</u>. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final report to 100th ASG, and other Government personnel. The AE shall prepare

slides or view graphs showing the results of the study to date for his presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide the comments from all reviewers and written notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require a minimum of one working day. The presentation and review conferences will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.5.1 Interim Submittal (35%). An interim report shall be submitted within 90 calendar days after Notice To Proceed for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. A sample implementation document (DA Form 5108-R, sketches and manufacturers data, life cycle cost analysis summary sheet and supporting data) for one project shall be submitted with this submittal for review and approval. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.5.2 Prefinal Submittal (95%). The AE shall prepare and submit the prefinal report complete with all work under this project within 60 calendar days after receipt of Government comments on Interim submittal. The AE shall submit the Scope of Work for the installation studied and any modifications to the

* 95% means complete report in every detail.
100% merely incorp. Govt's comments w/o addl allowance.

Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. The energy savings presented shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. Completed programming and implementation documents for all recommended projects shall be included. The programming and implementation documents shall be ready for review and signature by the installation commander. The prefinal report, separately bound Executive Summary and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex C for minimum requirements), (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) appendices to include the detailed calculations and all backup material and (d) the programming and implementation documentation. A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost.

7.6.3 Final Report (100%). The final report will be delivered within 30 calendar days after the A/E has been provided in writing the acceptance of prefinal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation and review conference shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages.

7.6.3 Distribution of Final Report:

Commander 100th ASG, ATTN: AETT-DEH-OMU Unit 28130 (Ms. Graf) APO AE 09114	Original Field Notes with 3 copies - Interim Submittal 3 copies - Prefinal Submittal 2 copies - Final Report and 1 Set of WP 5.1 disks
Commander HQ USAREUR, ATTN: AEAEN-EH-U Unit 29351 (Ms. Jenicek) APO AE 09014	1 Interim Submittal 1 Exec. summ. Prefinal & Final 1 Prefinal & Final Report
Commander U.S.Army Troop Support Agency ATTN: LOTA-EM-E (Mr. Kuney) Fort Lee, VA 23801-6020	1 Executive summary 1 Final report
Commander US Army Corps of Engineers ATTN: CEMP-ET (Mr. Gentil) 20 Massachusetts Avenue NW Washington, DC 20314-1000	1 Executive summary- Prefinal and Final
Commander USAED, Transatlantic Division ATTN: CETAD-EC-MD (Mr. Farrand) P.O. Box 2250 Winchester, VA 22601-1450	1 Prefinal 1 Final Report
Commander US Army Engineer District, Europe ATTN: CETAE-PM-ME (~~Sidwani~~) Unit 25727 (Ganguli) APO AE 09242	1 Correspondence 1 Interim Submittal with field notes 1 Prefinal submittal 1 Final Report
Commander US Army Engineer District, Mobile ATTN: CESAM-EN-CC (Mr. Battaglia) PO Box 2288 Mobile, AL 36628-0001	1 Executive summary Prefinal & Final 1 Final Report
Commander US Army Logistics Evaluation Agency ATTN: LOEA-PL (Mr. Keath) New Cumberland Army Depot New Cumberland, PA 17070-5007	1 Executive summary- Prefinal & Final
Commander U.S. Army Engineer Division, Huntsville ATTN: CEHND-ED-ME-CP (Mr. Holland) PO Box 1600, Huntsville, AL, 35807-4301	EMCS review only.

ANNEX A

ENERGY CONSERVATION OPPORTUNITIES

- Insulation (wall, roof, pipe, duct, etc.)
- Insulated glass or double glazed windows
- Weather stripping and caulking
- Insulated panels
- Solar films
- Vestibules
- Reduction of glass area
- Shutdown energy to hot water heaters or modify controls
- Energy conserving fluorescent lamps and ballasts
- Reduce lighting levels
- Replace incandescent lighting
- Night setback/setup thermostats
- Infrared heaters
- Economizer cycles (dry bulb)
- Heat reclaim from kitchen exhaust
- Heat recovery from dishwasher hot water
- Booster heaters at major hot water users
- Lower domestic hot water temperatures
- Upgrade HVAC controls
- Make HVAC operations more efficient
- Optimize dining facilities operation

- Balance HVAC systems
- Change to Variable Air Volume (VAV) system
- Use air curtains/plastic strips at personnel entrances
  - Install make-up air supply for kitchen area
- Shut off range hood exhaust whenever possible
- Use of heat pump to heat domestic hot water and cool dining area
- Waste heat recovery
- Thermal storage
- Steam trap inspection
- Instantaneous hot water heaters
- Destratification
- Convert to energy efficient/smaller motors
- Reflectors for fluorescent fixtures
- Occupancy sensors (lighting and HVAC)
- Replace kitchen exhaust hoods with energy efficient models
- Photocells for lighting
- Timers for lighting
- Low emissivity windows
- Separate switches to control lighting arrangements

ANNEX B

DETAILED SCOPE OF WORK

Dining Facility Data

	Grafenwoehr Bldg 101	Vilseck Bldg 606
People (Average)	500 per meal	350 per meal
Space	9806 sq.ft= 883 sq.m	17 298 sq.ft=1557 sq.m
Freezers	1 Walk-in	1 Walk-in
Refrigerators	3 Walk-in Other Refrigerating Eqpt.	2 Walk-in Other Refrige.Eqpt.
District Heat	EMCS installed	EMCS being installed
Lighting	Flourescent & Incandesc	Flourescent,660-75 W
Floor Plan	Per As built drawing	Per As built drawing

Note: Use of the International System of Units (SI)- the Modernized Metric System per ASTM E-380 will be made in this study along with other units. ~~9 ECOs per facility will be defined during the prenegotiation site visit.~~

The following items will be furnished to the AE by the Government:

ASG (1) Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP). Only portions pertaining to dining facilities, if any, need to be made available.

ASG (2) Latest copies of other energy studies performed since the previous EEAP study. Only portions pertaining to dining facilities, if any, need to be made available.

USAREUR (3) Energy Resources Management Plan.

EUD (4) ETL 1110-3-282, Energy Conservation.

2 (5) Architectural and Engineering Instructions.

USAREUR (6) Energy Conservation Investment Program (ECIP) Guidance, dated 28 June 1991 or latest guidance available from the U.S. Engineering and Housing Support Center, Fort Belvoir, VA.

ASG (7) TM 5-785, Engineering Weather Data; TM 5-800-2, General Criteria Preparation of Cost Estimates; and TM 5-800-3, Project Development Brochure.

EUD USAREUR (8) AR 415-17, Cost Estimating for Military Programming; AR 415-20, Construction, Project Development and Design Approval; AR 415-28, Department of the Army Facility Classes and Construction Categories; AR 415-35, Construction, Minor Construction; AR 420-10, General Provisions, Organization, Functions, and Personnel; AR 11-27, Army Energy Program, and USAREUR Pamphlet 5-5.

2 (9) The latest Tri-Service MCP Index.

ASG / USAREUR (10) An example of a correctly completed implementation document for a project.

USAREUR (11) Draft Manual TM5-815-2/NAVFAC DM-4.09/AFM 88-36 dated Feb.1988, Energy Monitoring And Control Systems.

(12) USAREUR Regulation 420-43, Electrical Services, para 15.b, lists references required for EMCS in USAREUR.

~~The simulation programs acceptable for use in this study are listed below. Any substitutes must be submitted and approved as outlined in the basic scope of work.~~

~~a. Building Loads and System Thermodynamics (BLAST)~~
~~b. DOE 2.1B~~
~~c. Carrier E20 or Hourly Analysis Program (HAP)~~
~~d. Trane Air-Conditioning Economics (TRACE)"~~

Energy Monitoring and Control System (EMCS) shall be surveyed at both the dining facilities and the state- of- the- art recommendations provided.

USAREUR A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

ANNEX C

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, similar facilities, sizes, etc.).

3. Present Energy Consumption.

   - o Total Annual Energy Used.

   - o Source Energy Consumption.

     Electricity - kWh(Megajoule), DM, BTU(Joule)
     District Heat- kwh(Megajoule), DM, BTU(Joule)
     Natural Gas - THERMS(cubic metres), DM, BTU(Joule)
     Propane - GALS(Litres), DM, BTU(Joule)
     Other - QTY, DM, BTU(Joule)

   - o Energy Consumption by Systems.

4. Historical Energy Consumption.

5. Energy Conservation Analysis.

   - o ECOs Investigated.

   - o ECOs Recommended.

   - o ECOs Rejected. (Provide economics or reasons)

   - o ECIP Projects Developed. (Provide list)*

   - o Non-ECIP Projects Developed. (Provide list)*

   - o Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost. Show the simple payback period for all ECOs.

6. Energy and Cost Savings.

   - o Total Potential Energy and Cost Savings.

- o Percentage of Energy Conserved.
- o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

7. Energy Plan.

- o Project Breakouts with Total Cost and SIR.
- o Schedule of Energy Conservation Project Implementation.

8. Required DD Form 1391 Data.

o To facilitate ECIP project approval, the A/E will provide ECIP data for completion of DD Form 1391 to be prepared by 100th ASG .

APPENDIX B

FIELD SURVEY NOTES

Baker

MEMORANDUM OF MEETING

Project: Gehrmann Energy Study	**S. O. No.:** 20098-BRM
Date: November 28, 1992	**Time:** 9:00 A.M.
Place: Grafenwohr Bldg. 433	**Memo By:** Ted Marstiller

Subject: Kick-Off Meeting

Attending:

Name	Company	Telephone
Lindy Wolner	CETAE - PM - ME	069151-7677
Roland Repper	DEH 409th BSB	475-7144
Elfriede Rieger	DEH 281st BSB	476-2944
Angie Graf	DEH 100th ASG	475-6143
Jurgen Heyer	UC Umwelt	0611-700003
Heinz Lehnij	Gehrmann Consult	0611-717331
Rainer Solbach	Gehrmann Consult	0611-7170
Walt Lerian	Baker and Associates	(412) 269-6277
Ted Marstiller	Baker and Associates	(412) 269-6246

Discussion:

1.0 Walt Lerian introduced the members of the Gehrmann/Baker Survey Team to the Army and explained each member's specialty and role in the survey.

2.0 Walt Lerian then explained what the survey team hoped to achieve during the week. The time table agreed upon is as follows:

Monday	-	Kick-Off Meeting; Survey of Grafenwohr Building 101
Tuesday	-	Survey of Vilsek Building No. 603
Wednesday	-	Final survey of either/both buildings, as necessary
Thursday	-	Exit interview scheduled for 9:00 A.M., Building 433, Grafenwohr.
Friday	-	Exit interview with Mr. Lindy Wolner at EUD offices in Frankfort

3.0 Lindy Wolner then explained what the Army hoped to achieve through this survey.

4.0 Angie Graf explained that she would be the official point-of-contact for the Grafenwohr site, and that Roland Repper would be assisting her as a technical point of contact. Herr Repper would be in charge of providing drawings as well as any technicians required to assist the survey team.

5.0 Elfriede Rieger explained that she would be the point-of-contact for the Vilsek site.

6.0 The survey team was given the following documents:

a. Utility plans for Grafenwohr Building 101 and Vilsek Building 603.

b. An ECIP Guidance Memorandum from CEHSC-FU-M outlining the latest Army policy concerning ECIP development.

c. Energy Audits (Executive Summaries, only) for dining facilities at Ft. Carson, The Presidio, and Ft. Campbell.

7.0 Major Graf stated that she was interested, primarily, in no-or-low cost ECO's since money for implementing ECO's is limited.

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MEMORANDUM OF MEETING

Project: Grafenwöhr/Vilseck Energy Audit **S. O. No.:** 20098-25-BRM

Date: November 30, 1992 **Time:** 11:00 A.M.

Place: Grafenwöhr, Germany **Memo By:** C. E. Marstiller

Subject: Site Survey of Building 101 - Dining Hall

Attending:

Name	Company	Phone
Jürgen Heyer	UC Umwelt	0611-700003
Heinz Lehnij	Gehrmann Consult	0611-717331
Rainer Solbach	Gehrmann Consult	0611-7170
Walt Lerian	Baker and Associates	(412) 269-6277
Ted Marstiller	Baker and Associates	(412) 269-6246

Discussion:

1.0 Building is relatively new (± 10 years old), red brick, single story structure with a flat roof.

2.0 All windows contain insulating, double pane glass set in wood frames.

3.0 Vestibules are present at the front door (main public entrance) and at the rear door (main entrance to kitchen). No vestibules are present at the emergency exit doors in the dining areas. Outer vestibule doors at kitchen entrance were open during entire survey period. Inner doors have screen windows. These doors are obviously open year-round to help cool and dehumidify the cooking area.

4.0 Kitchen equipment is maintained by an outside contractor (GEBE)- preventative maintenance was being performed on refrigeration equipment during both visits.

5.0 Numerous self-contained refrigeration units - ice machines, salad bars, cold drink dispensers,. etc. - are located throughout the kitchen and dining areas.

6.0 Dishwater was maintained in the ready state prior to lunch with the booster heater on. There is no supply air into the dishwasher area. Exhaust from dishwashing area is via an enameled, perforated "pan" ceiling. There is no specific exhaust connection to or hood directly over the dishwasher.

7.0 Make-up air type hoods are used over the serving line but not over the cooking area.

8.0 Cooking equipment was maintained in a "hot" state prior to lunch. Equipment should be turned on and off, as required, so that it is ready for use when needed but not operating unnecessarily.

9.0 Almost all of the equipment in the mechanical room is well insulated. However, some pipe insulation has been cut off well clear of pumps, valves, strainers, unions, etc. Insulation should be run as close as possible to pumps and removable covers should be provided at other devices. Duct insulation has sustained minor damage in some places.

10.0 Domestic hot water temperature is 97° F (36.1° C). Heating hot water is reset, automatically, by an O.A. temperature sensor.

11.0 Only one of the three HVAC units was running. The kitchen ventilation unit was running. The serving line ventilation unit and the dining room ventilation unit were not running. Only the dining room unit has return air ductwork connected to it. The kitchen and serving line ventilation units are 100% outside air units. All units are heating only (no air conditioning) with secondary loop pumps and 3-way control valves on the hot water piping to the unit coil.

12.0 Bag filters are provided on each air handler. Bags on dining room and serving line units were clean. Manometer on kitchen unit (operating) indicated that the pressure drop across the filters was negligible and that filters were clean.

13.0 Make-up air units located on the building's roof are matched to exhaust fans and to make-up type hoods. The make-up air units do not have a heating coil in them.

14.0 The exterior lights at loading dock were turned on at noon.

15.0 Night set-back of space temperature is handled through the central control system. The local control panel is located in the mechanical room. It is connected to a computer-based, campus-wide energy management system.

16.0 Outdoor design temperature (winter) for Grafenwöhr is 0° F (-17.8° C).

17.0 Lighting fixtures in the dining area are recessed, three lamp type fluorescent fixtures. Fluorescent cove light is provided around the perimeter of the dining areas. All lighting in the food preparation and serving areas is fluorescent.

18.0 The Dining Hall serves 400-500 meals for lunch and dinner, breakfast is said to be a much smaller meal, but exact number of meals served was not indicated.

19.0 Dining Hall operating hours are as follows:

	Mon, Tue, Wed, Fri	Thur	Sat, Sun
Breakfast	0530-0745	0530-0700	0700-0830
Lunch	1115-1300	1115-1300	1200-1330
Dinner	1630-1800	1630-1800	1600-1730

20.0 Clean-up after each meal takes 1-1/2 hours. Cooking and food prep prior to each meal takes 2 hours. Baking occurs between 1600-2400 each evening.

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Baker

MEMORANDUM OF MEETING

Project: Grafenwöhr/Vilseck Energy Audit

S. O. No.: 20098-25-BRM

Date: December 1, 1992

Time: 9:30 A.M.

Place: Vilseck, Germany

Memo By: C. E. Marstiller

Subject: Site Survey of Building 603 - Dining Hall

Attending:

Name	Company	Phone
?	DEH 281st BSB (Kick-Off Meeting Only)	?
Elfriede Rieger	DEH 281st BSB	476-2944
?	DEH 281st BSB	?
Jürgen Heyer	Gehrmann Consult	0611-700003
Heinz Lehnij	Gehrmann Consult	0611-717331
Rainer Solbach	Gehrmann Consult	0611-7170
Walt Lerian	Baker and Associates	(412) 269-6277
Ted Marstiller	Baker and Associates	(412) 269-6246

Discussion:

1.0 A brief Kick-Off Meeting was held prior to the survey of Building 603. At this meeting, the survey team presented a brief description of what it was attempting to achieve and the methodology by which the work was to be preformed.

2.0 Several operational procedures were outlined by Herr ___?___ in response to questions posed by the survey team. These are as follows:

a. Night-time temperature set-back is presently used to conserve heating energy at all dining facilities. Set-back function is presently being performed by timers. However, a site-wide, computer-based Energy Management System is currently being installed.

b. The temperature of the heating hot water is re-set (at the heat exchanger) by an outdoor air temperature sensor.

c. It was not clear if there were electrical interlocks between the exhaust hoods and the make-up air units.

d. District hot water is supplied to the dining hall by the same vendor supplying Grafenwöhr. A copy of the contract will be provided for the survey team's use.

e. Approximately 650-700 meals are served at the lunch and dinner meals. Capacity of the facility is 1000 meals per sitting.

3.0 The survey team, accompanied by E. Rieger and ____?____ then traveled to Building 603 to conduct the site survey. The building is a single story, orange brick building with three peaked roofs running the entire width of the building. These attic areas house the air handling equipment.

4.0 There are no vestibules at front entry doors. A corridor running the entire width of the building (between the two, main double-door entries) acts as a vestibule. One leaf of one of the entry doors was left open the entire day due to a broken door closer. Air curtains (no heat, indoor air recirculating type) were provided at both doors. However, the air curtain over the open door never turned on.

5.0 Incandescent chandeliers were used to light the dining areas. The user has already cut electrical consumption in half by eliminating half of the bulbs (upward facing bulbs were removed, downward facing bulbs remain). Incandescent wall washers and down lights as well as cove-mounted fluorescent perimeter lights are also used in the dining areas.

6.0 Equipment - hoods, grilles, convection ovens, warming ovens, etc. - were all turned on without any cooking being done. Lights were turned on in areas not being used for cooking or serving. A printed directive mandating a maximum warm-up period of 15 minutes for equipment is posted on the wall. However, this directive is not being followed.

7.0 Energy conserving make-up air type hoods are being utilized. However, the permanent, cleanable type air filters being used are not properly sized for the hoods. In many areas there are 1"-2" gaps between the filters. This will allow grease to condense in the ductwork and on the exhaust fan.

8.0 A vestibule is provided at the rear entrance (to the kitchen). The inner doors have been blocked open.

9.0 Adhesive type insulation pins were used to hold the duct insulation (wrap) to the ductwork. The insulation has fallen on ducts greater than (18"-24") in width. Evidently the adhesive is not strong enough to support the insulation at the pin spacing used for this insulation.

10.0 A large central control panel located in the center (of three) mechanical rooms controls all of the mechanical equipment.

11.0 A large hole (±36" square) has been cut in the plastic vapor barrier and batt insulation hung from the bottom of the roof joists. This opening is allowing large quantities of raw outside air to be drawn into the attic mechanical space.

12.0 Primary-secondary pumping with 3-way modulating valves is used on all heating/ventilating units. Pipe insulation is generally in good condition, but is incomplete at many locations. Apparently the insulation covers manufactured for strainers, valves, etc. have been removed from some locations and never replaced. The duct insulation in the rear mechanical space (over the kitchen) has been crushed by miscellaneous kitchen equipment which is stored on top of it. The entire mechanical room is stuffed with dishes, trays, spare parts, seasonal display materials, old boxes, etc.

13.0 The mechanical room in which the hot water heat exchangers are located is uncomfortably hot. Heat exchangers appear identical to those used at Grafenwöhr. They are rated for 3000 liters at 95° C (203 °F) and are insulated. Domestic water temperature is maintained at 60° C (140° F). The caps on the primary (high temp) heat exchanger bodies are not insulated. Some insulation on water piping is missing.

14.0 The only units with return air connections are the three units serving the dining areas. These units are equipped with return air fans. Outside air is drawn in through wall mounted louvers and relief air is rejected through a ventilator on the roof. The dining area units were shut down after lunch was served.

15.0 The exhaust fan serving the dishwasher was still operating after the dishwasher was turned off. No one was in the dishwashing area after the lunch dishes were finished. Lights and exhaust should have been turned off.

16.0 Dining Hall hours are as follows:

	Mon, Tue, Wed, Fri	Thur	Sat, Sun
Breakfast	0700-0845	0500--0630	0800-0930
Lunch	1130-1300	1200-1330	1130-1300
Dinner	1700-1830	1600-1730	1600-1730

17.0 Cooking and food prep starts two hours before each meal. Clean-up takes two hours after each meal. Baking is done between 2200 and 0400 each night.

CEM/tas

INSPECTION REPORT - ELECTRICAL

Table of Contents

622 58.M

1. Grafenwöhr Dining Facility Building 101

1.1 Electrical Power Consumption

The electrical power consumption has been metered in 1992 for the months of May - November, as follows:

Month	Reading	Factor	Power Consumption in kWh
May	466.0	120	55920
June	351.4	120	42168
July	434.7	120	52164
August	457.9	120	54948
September	392.5	120	47100
Oktober	397.5	120	47700

The average consumption for the applicable period amounts to

50,000 kWh per month.

The percentage share of the Dining Facility 101 of the total power consumption of the Grafenwöhr site amounts to

2.13 %.

1.2 Description of the Electrical Systems

1.2.1 Electrical Power

1.2.1.1 Main Power Supply/Main Distribution Panel

Main power supply is provided from the transformer station by means of a duplex cable 2 x NYCWY 3 x 150/70 (approx. 70 m) with 380 V phase conductor voltage, 50 Hz frequency. The main distribution panel is located in a separate room and includes the

- main circuit breaker	630 A
- circuit breaker for SDP 1	400 A
- circuit breaker for SDP 2	400 A

The busbar has a capacity of 800 A. The power consumption is metered by means of a transducer meter.

1.2.1.2 Subdistribution Panels/Electrical Systems

The subdistribution panel SDP 1 is also located in the main distribution room. Large kitchen appliances, refrigerators, the HVAC control panel, and the lighting/receptacles circuits are served from this panel. The busbar is designed for 630 A.

Subdistribution panel SDP 2 is located in the kitchen corridor. Small kitchen appliances, lighting/receptacle circuits, and the dishwasher are served from this panel. The busbar is designed for 400 A.

Fault current protection has been applied to some power circuits only.

L type miniature circuit breakers are used for lighting/receptacle circuits, and G type miniature circuit breakers for kitchen equipment.

1.2.2 Lighting Systems

1.2.2.1 Dining Area

The dining area and the passages are mainly illuminated by means of fluorescent light fixtures with 40 W and/or 36 W fluorescent lamps (acc. to as-built plan).

The following light fixture types are used:

- Recessed large grid, mirror light fixture
- Surface mounted light fixture, open type
- Recessed incandescent ceiling reflector
- Recessed opal glass light fixture

The light intensities are as follows:

Dining room	over 150 lx
Entrance area and corridor	150 lx
Serving area	250 lx

The light efficiencies are relatively low, due to the fact that light fixtures without or with poor reflectors have been used.

All light fixtures are equipped with conventional type ballasts.

The installed electrical lighting capacity is designed as follows:

Dining room	72 x 36 W =	2593 W
	47 x 36 W =	1692 W
Entrance hall	19 x 36 W =	684 W
Serving area	50 x 36 W =	1800 W
Power loss of ballasts	188 x 13 W =	2444 W
Incandescent lamps	7 x 100 W =	700 W
Connected electric load	=	9912 W

The lights are manually controlled by groups.

1.2.2.2 Kitchen and Service Rooms

The kitchen and service rooms are illuminated by means of fluorescent light fixtures with 40 W and/or 36 W fluorescent lamps (acc. to as-built plan).

The following light fixture types are used:

- Recessed, large grid, mirror light fixtures
- Surface mounted light fixture with opal or prism diffuser
- Moisture protected light fixtures for the ventilating ceiling

The light intensities are as follows:

Kitchen area	450 - 700 lx
Service rooms	150 - 200 lx
Dishwashing area	50 lx
Office	400 lx

The light efficiencies are relatively low, due to the fact that light fixtures without or with poor reflectors have been used.

All light fixtures are equipped with conventional type ballasts.

The installed electrical lighting capacity is designed as follows:

Kitchen area	90 x	36 W	=	3240 W
Service rooms	38 x	36 W	=	1368 W
Dishwashing area	24 x	36 W	=	864 W
Corridor/office	18 x	36 W	=	648 W
Power loss of ballasts	170 x	13 W	=	2210 W
Connected electric load	=			8330 W

The lights are manually controlled by groups.

1.2.2.3 Exterior Lighting

The exterior areas, such as receiving ramp and garbage can washing area are illuminated by means of recessed fluorescent light fixtures with prism diffuser.

Ramp	16 x	36 W =	576 W
Garbage can washing area	4 x	36 W =	144 W
Power loss of ballasts	20 x	13 W =	260 W
Connected electric load =			980 W

The lights are manually controlled.

The exterior areas, such as parking areas and access ways are illuminated by means of pole mounted light fixtures with high pressure mercury vapor lamps.

Lighting poles	15 x	125 W =	1875 W
Power loss of ballasts	15 x	20 W =	300 W
Connected electric load =			2175 W

The lights are controlled by means of a twilight switch.

1.3 Electrical Kitchen Equipment

The following electrical kitchen equipment is installed in the kitchen area:

- Subdistribution panel SDP 1

Item No.	Circuit No.	Description	Rating in kW	Voltage
171	1.01	Baking oven		
171	1.02	Baking oven		
171	1.03	Baking oven		
182	1.04	Electric range		
175	1.05	Frying pan		
155	1.06	Deep fat fryer		
155	1.07	Deep fat fryer		
163	1.08	Steam kettle		
146	1.09	Steam cooker		
165	1.10	Steam kettle		
166	1.11	Steam kettle		
198	1.14	Booster		
-	1.20	Dough proofing cabinet		
-	1.21	Dough proofing cabinet		
-	1.22	Dough proofing cabinet		
168	1.23	Mixing machine		
148	1.24	Vegetable cutting machine		
196	1.25	Vegetable peeling machine		
150	1.26	Cooking grease filter		

- Subdistribution panel SDP 2

Item No.	Circuit No.	Description	Rating in kW	Current in V
80	2.31	Milk dispenser		
60	2.32	Ice cream cabinet		
72	2.33	Beverage dispenser		
72	2.34	Beverage dispenser		
79	2.35	Tea dispenser		
70	2.36	Beverage dispenser		
63	2.37	Water chiller		
77	2.39	Ice dispenser		
76	2.42	Hot chocolate dispenser		
63	2.43	Water chiller		
70	2.44	Beverage dispenser		
79	2.45	Tea dispenser		
72	2.46	Beverage dispenser		
72	2.47	Beverage dispenser		
77	2.49	Ice dispenser		
95	2.51	Ice cream maker		
96	2.52	Ice cream maker		
80	2.54	Milk dispenser		
69	2.55	Cold food counter		
69	2.56	Cold food counter		
67	2.55	Cold food counter		
42	2.58	Sandwich unit		
9	2.59	Cold food counter		
9	2.60	Cold food counter		

cont'd

- Subdistribution SDP 2

Item No.	Circuit No.	Description	Rating in kW	Current in V
101	2.61	Refrigerator		
37	2.62	Refrigerator		
33	2.63	Refrigerator		
90	2.64	Ice cube machine		
113	2.80	Coffee machine		
22	2.82	Griddle		
46	2.83	Food warming cabinet		
58	2.84	Infrared food warmer		
50	2.85	Hot food table		
51	2.88	Hot food table		
22	2.89	Griddle		
22	2.90	Griddle		
23	2.93	Roller grill		
58	2.94	Infrared food warmer		
155	2.95	Fryer		
55	2.98	Toaster		
2	2.99	Food warming cabinet		

The above list has been taken from the as-built drawing 36-09-162 sheet E1 and E2.

1.4 Mechanical Systems

HVAC drivers are listed below:

Cable No.	Description	Rating in kW	Current in A
15	Circ. pump 2 (boiler)	0.34	1.1
16	Circ. pump 1	0.12	0.58
17	Circ. pump 2	0.12	0.58
18	Circ. pump, mix water	0.12	0.50
20	Circ. pump, dom. water	0.025	0.14
25/26	Pump 1	0.54	1.3
27/28	Pump 2	0.54	1.3
31	Sec. pump, kitchen ventil.	0.138	0.55
38-40	Supply air fan, kitchen	6.6/2.6/0.6	
41	Exh. air fan, roof, kitchen	2.2	5.8
44	Exh. air fan, pers. room	0.55	1.63
45	Exh. air fan, pot washing	0.55	1.63
47	Exh. air fan, smoke exh.	1.1	2.8
50/51	Supply air fan, exh. hood 1	3.7/0.5	
52/53	Exh. air fan, exh. hood 1	3.7/0.5	
55/56	Supply air fan, exh. hood 2	1.66/0.33	
58/59	Exh. air fan, exh. hood 2	1.66/0.33	
65	Sec. pump, serving counter	0.138	0.55
70-72	Supply air fan, serv. count.	9.5/3.7/0.9	
73	Exh. air fan, serv. area	0.55	1.63
76	Exh. air fan, self service	2.2	5.8
77	Exh. air fan, dishwashing	2.2	5.2

Cable No.	Description	Rating in kW	Current in A
82/83	Supply air, exh. hood 1, serving counter	1.72/0.45	
85/86	Exhaust air, exh. hood 1, serving counter	1.72/0.45	
89/90	Supply air, exh. hood 2, serving counter	1.72/0.45	
92/93	Exhaust air, exh. hood 2, serving counter	1.72/0.45	
96/97	Supply air, exh. hood 3, serving counter	0.83/0.13	
99/100	Exhaust air, exh. hood 3, serving counter	0.83/0.13	
106	Exhaust air, latrine	0.55	1.63
107	Sec. pump, ventil.	0.149	0.44
113	Supply air fan, dining area	3.0/0.9	7.1/3.4
114	Exh. air fan, dining area	2.1/0.75	4.8/2.2
115	Exh. air fan, dining area	2.2	5.2
124	Exh. air fan, compressor	0.55	1.63

1.5 Energy Saving Opportunities

1.5.1 Main Power Supply

The existing duplex cable system 2 x NYCWY 3 x 150/70 (70 m) has a capacity of max. 696 A. The present average load current amounts to approx. 300 A.

With the load current of 300 A the power loss to the transformer station amounts to max. 1.44 kW.

The voltage loss amounts to 2.76 V.
This corresponds to 0.7 %.

The existing main power supply system is adequately dimensioned. An extension for power saving purposes is not required.

1.5.2 Lighting System

With the same light intensity, the number of 36 W lamps can be reduced from presently 380 ea to 334 ea by installation of electronic ballasts.

Following is a sample cost estimate:

	conventional ballasts	electronic ballasts
Number of 36 W lamps	380	334
Connected load	18.62 kW	12.02 kW
Power cost per year (0.30 DM/kWh; 2800 h/y)	15,640.80 DM	10,096.80 DM
Rel. power cost	100 %	64.56 %

A further reduction of the number of light fixtures can be obtained by the use of improved efficiency light fixtures.

1.5.3 Electrical Equipment

Energy saving on electrical kitchen appliances is feasible when attention will be paid to the fact that any newly purchased equipment has control features to prevent overheating, stepless power control devices, timers, etc., and has adequate heat insulation. An other opportunity consists in switching to energy saving cooking, baking, and proofing methods.

1.5.4 Mechanical Systems

Fifteen drivers of over 1 kW capacity are installed in the HVAC system.

The required capacities can be better adjusted to suit the requirements by means of stepless speed control systems.

The operation can be optimized by connection to centralized building control systems.
The facilities are designed for this purpose.

2. Vilseck Dining Facility Building 603

2.1 Electrical Power Consumption

The electrical power consumption has been metered in 1992 for the months of May - September, as follows:

Month	Reading	Factor	Power Consumption in kWh
May	224.0	250	56000
June	250.0	250	62500
July	259.0	250	64750
August	259.0	250	64750
September	220.0	250	55000

The average consumption for the applicable period amounts to

60,600 kWh per month.

No statement can be made on the percentage share of the Dining Facility 603 of the total power consumption of the Vilseck site.

The specified consumption does not include the power consumption of:

- HVAC distribution panels
- Ventilating system control panels
- Dishwasher SDP 5
- Lighting/receptacles SDP 2/3
- Emergency lighting SDP 4

all in field 6 - 9

On the inspection day the load current of the dining facility amounted to approx. 200 A per phase conductor. The max. current reading was 260 A per phase conductor.

2.2 Description of the Electrical Systems

2.2.1 Electrical Power

2.2.1.1 Main Power Supply/Main Distribution Panel

Main power supply is provided from the transformer station by means of a duplex cable 2 x NYCWY 3 x 185/95 with 380 V phase conductor voltage, 50 Hz frequency.

The main distribution panel is located in a separate room and includes the following fields:

Field 1
- mains feed
- main circuit breaker 800 A (kitchen field 2-5)
  busbar 1000 A
  transducer meter
- circuit breaker 500 A (special field 7)
  busbar 760 A

Field 2-5 - Outgoing lines for kitchen equipment

Field 6 - Emergency lighting

Field 7 - Outgoing lines for HVAC, hot water generator, subdistribution panels 2-5 (field 8. 9) refrigerating equipment

Field 8 - Lighting

Field 9 Lighting/receptacles

2.2.1.2 Subdistribution Panels/Electrical Systems

The subdistribution panels are located in the main distribution panel room and are composed of the fields 6-9.

In addition, there is a heating control panel and a ventilating system control panel.

The electrical wiring system is in good condition.

Fault current protection is available with 30 mA.

L type miniature circuit breakers are used for lighting/receptacle circuits, and G type miniature circuit breakers for electrical equipment.

2.2.2 Lighting Systems

2.2.2.1 Dining Area

The dining rooms and the passages are mainly illuminated by means of incandescent light fixtures as follows:

Dining room R12	- inc. lamps	360 x 40 W =	14400 W
		5 x 130 W =	750 W
			15150 W
Dining room R16	- inc. lamps	360 x 40 W =	14400 W
		5 x 130 W =	750 W
			15150 W
Passage R11	- fl. lamps	23 x 36 W =	828 W
Passage R17	- fl. lamps	23 x 36 W =	828 W
Passage R10	- inc. lamps	17 x 150 W =	2550 W
Passage R13	- inc. lamps	14 x 150 W =	2100 W
Passage R15	- inc. lamps	14 x 150 W =	2100 W
Entrance area	- inc. lamps	11 x 150 W =	1650 W
Toilet R1-4	- fl. lamps	10 x 36 W =	360 W
Connected electric load	=		40716 W

The incandescent lamp lighting has already been reduced by 50 % by personnel, so that only max. 180 ea 40 W incandescent lamps per dining room are operated.

The light intensity in the dining area was approx. 50 lx, and 150 lx in the lateral areas and in the passages.

The lights are manually controlled by groups.

2.2.2.2 Kitchen and Service Rooms

The kitchen and service rooms are illuminated by means of fluorescent light fixtures with 36 W fluorescent lamps.

The following light fixture types are used:

- Recessed, large grid light fixtures
- Moisture protected light fixtures, open type
- Surface mounted light fixtures for the cold storage room
- Recessed light fixtures with mirror reflector
- Light fixtures in the exhaust hoods

The light intensities are as follows:

Kitchen area	450 - 700 lx
Serving areas	200 - 350 lx
Dishwashing area	50 lx

The light efficiencies are relatively low, due to the fact that light fixtures without or with poor reflectors have been used.

All light fixtures are equipped with conventional type ballasts.

The installed electrical lighting capacity is designed as follows:

Kitchen area	102	x	36 W	=	3672 W
Serving areas	132	x	36 W	=	4752 W
Dishwashing area	40	x	36 W	=	1440 W
Service rooms	88	x	36 W	=	3168 W
					13032 W
Power loss of ballasts	362	x	13 W	=	4706 W
Connected electric load	=				17738 W

The lights are manually controlled by groups.

2.2.2.3 Exterior Lighting

The exterior areas, such as receiving ramp and entrance/exit doors are illuminated by means of open type, single lamp, fluorescent light fixtures.

Ramp	4 x	36 W =	144 W
Entrance/exit doors	3 x	36 W =	108 W
Power loss of ballasts	7 x	13 W =	91 W
Connected electric load =			343 W

The lights are manually controlled.

2.3 Electrical Kitchen Equipment

The following electrical kitchen equipment with the following ratings is installed in the dining facility:

Item No.	Description	Qty.	Rating in kW	Voltage
2	Food warming cabinet	2	4.0	380
3	Food warming cabinet	2	1.0	220
6	Fryer	2	12.5	380
22	Griddle w/ base cabinet	8	14.0	380
33	Refriger., reach-through	2	0.35	220
35	Refrigerator	2	0.4	220
42	Refr. sandwich unit	2	0.2	220
46	Warming cabinet W/ drawers	2	1.0	220
51	Hot food counter, mobile	4	7.0	380
55	Toaster	2	4.0	220
56	Toaster, autom.	2	2.6	220
62	Ice cream cabinet	1	0.6	220
68	Cold food counter	2	0.2	220
69	Cold food counter	3	0.2	220
70	Carbon. beverage dispsens.	2		5x220
72	Juice dispenser	2x3	0.15	3x220
77	Ice cube dispenser, mobile	4	0.25	220
80	Cold milk dispenser	3	0.7	220
90	Ice cube machine	2	0.74	220
92	Cold stand, milk	3	0.7	220
96	Ice cream machine	2	3.8	220

Item No.	Description	Qty.	Rating in kW	Voltage
101	Refrigerator	1	0.4	220
105	Vacuum cleaner	1	1.25	220
113	Coffee mach. w/ hot water	2	12.0	380
114	Belt conveyor	2	0.37	220
120	Dishwasher	1	2/2/9/24	380
143	High pressure cleaner, mobile	1	1.1	220
143A	High pressure cleaner, wall mounted	1	1.5	220
146	Steam unit w/ 1x163 each	2	24	380
148	Vegetable cutting machine	1	0.75	380
150	Cooking grease filter, mobile	1	0.75	380
155	Fryer	3	22	380
158	Exhaust hood with fire extinguishing system	2		220
161	Exhaust hood with fire extinguishing system	1		220
163	Kettle, electric., 40 ltr	1	24	380
164	Kettle, 80 ltr	1	18.6	380
165	Kettle, 150 ltr	1	18/12=30.6	2x380
167	Food mixing machine	1	0.75	220
168	Stirrer/beater, 60 ltr	1	1.5	380
170	Can opener	2	0.75	220
171	Hot air unit	3	1.5/27/27	2x380
172	Refrigerator	1	0.25	220
175	Frying pan	2	16.8	380

Item No.	Description	Qty.	Rating in kW	Voltage
181	El. range with oven	1	11.5/6	2x380
182	El. range with oven	1	11.5/6	2x380
183	Refrigerator	1	0.5	220
186	Meat slicing machine	2	0.25	220
194	Dough proofing cabinet with humidifying system	2	1.0	220
196	Potato peeler with starch separator	1	0.55	380
198	Hot water gen.for 80°C	1	15.0	380
200	Exhaust hood	1		220
222	Walk-in deep freezer	1	1.5	380
223	Walk-in refrigerator	1	1.2	380
224	Walk-in refrigerator	1	1.2	380
228A	Ice cube machine	1	0.9	220
233	Storage cabinet for hot hamburgers	1	0.9	220
234	Carbon. beverage dispenser	1		5x220
235	Ice dispenser, mobile	1	0.6	220
236	Fryer	1	12.5	380
237	Exhaust hood with fire extinguishing system	1		220
238	Griddle w/ base cabinet	1	14.0	380
239	Refrigerator	1	0.4	220
242	Toaster	2	0.2	220

The above list has been taken from the as-built drawing 30-09-06 94.

2.4 Mechanical Systems

2.4.1 Freezers and Refrigerators

Approx. 21 freezing and refrigerating units are installed, with an average connected load of 1.32 kVA.

Total connected load: 27.7 kVA

2.4.2 Hot Water

Hot water is heated for domestic use by means of a heat exchange located within the hot water storage tank. The heat source is the District hot water system.

Hot water for the dishwasher is boosted from 60°C (140°F) to 80°C (176°F) by a 15kW booster heater located near the dishwasher.

2.4.3 Heating and Ventilating Drives

HVAC drivers are listed below:

- Ventilating Control Panel II

Cable No.	Description	Rating in kW	Current in A
14	Fan	6.6/2.6/0.6	13.2/6.2/2.7
15	Fan	4.4/1.85/0.4	11/5.8/2.45
19	Supply air fan	2.2	5.1
20	Exhaust air fan	2.2	5.2
24	Supply air fan	3	7.3
25	Exhaust air fan	3	7.6
29	Supply air fan	3	7.3
30	Exhaust air fan	3	7.6
34	Supply air fan	3	7.3
35	Exhaust air fan	3	7.6

cont'd

- Ventilating Control Panel II

Cable No.	Description	Rating in kW	Current in A
44	Exhaust air fan	0.37	1.12
16	Motorized thermocontact		0.65
52	Fan	0.37/0.12	1.3/0.5
54	Vertical el. room	3	7.6
50	Motorized thermocontact		0.36

- Ventilating Control Panel IV

Cable No.	Description	Rating in kW	Current in A
118	Fan	3.0/0.9	7.4/2.4
119	Fan	3.0/0.9	7.4/2.4
120	Pump	0.7	0.18
137	Fan	3.0/0.9	7.4/2.4
138	Fan	3.0/0.9	7.4/2.4
139	Pump	0.7	0.18
153	Fan	3.7/0.9	9.7/3.8
154	Fan	2.5/0.55	6.1/2.1
155	Motorized thermocont.	0.2	0.7
158	Motorized thermocont.	0.13	0.35
160	Fan, electrical room	1.1	2.8
161	Fan, electrical room	1.1	2.8
162	Fan	0.37/0.12	1.3/0.5

2.5 Energy Saving Opportunities

2.5.1 Main Power Supply

The existing duplex cable system 2 x NYCWY 3 x 185/95 (150 m) has a capacity of max. 786 A. The present average load current amounts to approx. 240 A.

With the load current of 240 A the power loss to the transformer station amounts to max. 1.6 kW.

The voltage loss amounts to 3.87 V.
This corresponds to 0.96 %.

The existing main power supply system is adequately dimensioned. An extension for power saving purposes is not required.

2.5.2 Lighting System

2.5.2.1 Fluorescent Lights in Kitchen and Service Rooms

With the same light intensity, the number of 36 W lamps can be reduced from presently 370 ea to 326 ea by installation of electronic ballasts.

Following is a sample cost estimate:

	conventional ballasts	electronic ballasts
Number of 36 W lamps	370	326
Connected load	18.62 kW	11.73 kW
Power cost per year (0.30 DM/kWh; 2800 h/y)	15,640.80 DM	9,853.20 DM
Rel. power cost	100 %	63 %

A further reduction of the number of light fixtures can be obtained by the use of improved efficiency light fixtures.

2.5.2.2 Dining Area Lighting

The energy cost can be considerably reduced by the use of energy saving lamps.

With the same light intensity, one 15 W large bulb energy saving lamp can be installed in lieu of two 40 W incandescent lamps. A 150 W incandescent lamp can be replaced by a 20 W lamp.

	incand. lamps	energy saving lamps
Number of lamps	720 ea 40 W	360 ea 15 W
Connected load	38.7 kW	6.72 kW
Power cost per year (0.30 DM/kWh; 2500 h/y)	29,025.00 DM	5,040.00 DM
Rel. power cost	100 %	17.36 %

2.5.2.3 Exterior Lighting

All exterior light fixtures should be controlled means of twilight switches to save energy.

2.5.3 Electrical Equipment

Energy saving on electrical kitchen appliances is feasible when attention will be paid to the fact that any newly purchased equipment has control features to prevent overheating, stepless power control devices, timers, etc., and has adequate heat insulation. An other opportunity consists in switching to energy saving cooking, baking, and proofing methods.

2.5.4 Mechanical Systems

Thirtythree drivers of over 1 kW capacity are installed in the HVAC system.

The required capacities can be better adjusted to suit the requirements by means of stepless speed control systems.

The operation can be optimized by connection to centralized building control systems.
The facilities are designed for this purpose.

INSPECTION REPORT - MECHANICAL

On site inspections on 30 Nov 92 and 1 Dec 92

1.0.0 Grafenwöhr/Vilseck Dining Facilities (30 Nov 92)
Attendants as per separate list

1.1.0 Recommendations for reduction of energy consumption and costs.

1.1.1 Monitoring and control of the mechanical systems by means of a centralized building control system; presently, the systems (HVAC) are still controlled by means of decentral timers and/or individually based on personnel decisions.

According to information received from technical personnel the installation of a building control system is provided and presently in progress.

1.1.2 Installation of peak load programs to monitor the actual total connected loads with load drop connections for large consumers and/or time delayed connections over the building control system of para. 1.1.1.

The peak load program prevents peak loads beyond a maximum consumption limit (by building) and, thus, improvements of the rate discount factors of the energy supply company.

Despite substantially unchanged energy supply quantities per year, this may lead to considerable energy cost savings from the cost settlements with the energy supply company.

1.1.3 Investigation of the control connections of the unit heaters within the regulating systems

Based on the arrangement of the regulating valves, any not required heating energy will be returned to the return system. Result: The return temperature will be approached to the temperature level of the supply system (heat and/or energy losses through piping surfaces).

1.1.4 Based on the operating mode of the HVAC systems with 100 % fresh air, heat recovery exchangers are recommended to reduce the heating energy demand. However, due to the separate arrangement of the supply and exhaust air equipment components (supply air in the ground floor mechanical room, exhaust air on the flat roof of the building), these can be provided only as heat exchangers with piping system between fresh air and exhaust air exchangers.

Heat recovery as described above is possible for the HVAC systems:

- Kitchen: 8000 cbm/h; approx. 115 kW
- Serving area: 16500 cbm/h; approx. 240 kW
- Dining area: 12000 cbm/h; approx. 176 kW

However, an economic effectiveness is possible only with more than 5 to 7 operating hours per day, due to the relatively low heat recovery efficiency.

1.1.5 Miscellaneous

- Operating hours meters for fan and pump motors shall be installed to determine the operating periods of these units over extended periods.
- Dishwasher to be equipped with direct exhaust air duct to reduce heat and humidity output into the room (possible subsequent costs due to structural damages).
- Improve maintenance of the systems.
- Temperature measurements on the remote heating system (secondary side, burried piping system) between metering point of the heating energy consumption and connection points of the individual buildings to find out the heat losses to the ground.

2.0.0 Vilseck Dining Facility (1 Dec 92)

Attendants:

DEH:	Mrs. Rieger
	Mr. Alex
	Mr. Bater
Baker:	Mr. Walt Lerian
	Mr. Ted Marstiller
UC:	Mr. Heyer
GC:	Mr. Lehnig
	Mr. Solbach

2.1.0 Recommendations for reduction of energy consumption and costs.

2.1.1 Centralized building control system as per para. 1.1.1.

2.1.2 Peak load program with load drop connection as per para. 1.1.2.

2.1.3 Investigation of regulating system for unit heaters within the HVAC systems.

Generally, as described in para. 1.1.3, however, the supply lines between the heating room (transfer station) and the unit heater locations are very long, so that the heat losses are considerably higher than in para. 1.1.3 (Grafenwöhr).

2.1.4 Heat recovery exchangers

Generally, as described in para. 1.1.4, however, supply and exhaust air equipment located together in the attic over the dining facility. Installation of heat recovery exchangers with up to 70% efficiency (regulated heating pipe) and/or up to 80% (rotary exchanger) also possible, if required, by modification of the equipment and duct systems; HVAC systems:

- Kitchen:	22000 cbm/h;	approx. 270 kW
- Serving area:	22400 cbm/h;	approx. 295 kW
- Dishwashing area:	10000 cbm/h;	? (no info available)

The HVAC systems of the dining facility operate with mixed air.

2.1.5 Miscellaneous

- Operating hours meters as described in para. 1.1.5.

- Maintenance
  Although the systems are operating since 1986 only, they give a generally neglected impression; the duct insulation is partly removed or hangs down from the ducts (high heat losses in supply air ducts), the valves are not maintained and partly corroded. Improvement urgently required.

- The temperature in the heat transfer room is very high. Inspection and improvement, if required, of the heat insulation - also here, the heat insulation of valves has been partly removed and not replaced!

- HVAC system rooms on the roof:
  The rooms are used as storage rooms and "lumber room", so that maintenance work (ref. to above) is additionally complicated.
  The inadequate use causes also an increased fire risk.

- Temperature measurements in the remote heat distribution system (secondary side, burried pipes). Also refer to para. 1.1.5. Temperature of building connection on the day of inspection: supply 100 °C, return 82 °C.

03.04.93 15:05

T.O.# 20098-93-BRM
cc: WBL/PF
EFB
UFL/LEM

GEHRMANN CONSULT

GMBH + PARTNER KG · ARCHITEKTEN UND INGENIEURE
A.-Lincoln-Str. 34 · 6200 Wiesbaden · Tel.: 06 11 - 7 17.0

GC-FX-NO. :

Datum/Date: 2.04.93

Zeit/Time:

AN / TO : BAKER & ASSOCIATES
MR. TED MARSTILLER

FAX-NO.: 00141 22696097

Von / From : WOLFGANG RIEFKE

FAX-NO.: (0)611 - 7 40 88

Projekt/Project: GRAFENWÖHR / VILSECK

Proj.-No.: 4246

Betreff/Subject: ENERGY SURVEY

Page 1 of 11 Pages
Seite 1 von 11 Seiten

Wenn Sie nicht alle angegebenen Seiten erhalten haben, so teilen Sie uns dies bitte umgehend mit.
If you did not receive the number of pages indicated, please contact us as soon as possible.

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FAX 0341-451 22 56

Baker and Associates
Michael Baker Jr., Inc.,
Facility Planning and Design
Attn. Mr. Ted Marstiller
Airport Office Park, Bldg. # 3
420 Rouser Road
Coraopolis, PA 15108

IHR ZEICHEN	IHRE NACHRICHT	UNSER ZEICHEN	NEBENSTELLE	PROJEKT-NR.	DATUM
		Ri/Ra	.400	4246	02.04.93

Energy Survey Dining Facility Grafenwöhr/Vilseck

Dear Mr. Marstiller,

attached please find the minutes of meeting from 25.03.93 in Grafenwöhr, the lists of energy charges and consumptions for Grafenwöhr and Vilseck and the monthly meter reading for Grafenwöhr, Building , and Vilseck, Building 603.

Sincerely,

GEHRMANN CONSULT GMBH + PARTNER KG

Distribution:
GC/GL
GC/H. Malmberg
GC/H. Lehnig
GC/TI
GC/TAB

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AKTENVERMERK

GESPRÄCHSBESTÄTIGUNG

VERTEILER:

Baker & Ass.
UC/H. Heyer
GC/GL
GC/EL
GC/MA
GC/TI
GC/TAB

DATUM:	PROJEKTNUMMER:	DIKTATZEICHEN:	AKTENZEICHEN:
25.03.93	4246	Ri/Ra	

BAUVORHABEN:
Energy Survey Dining Facility Grafenwöhr/Vilseck

BESPRECHUNGSTAG- UND ORT:
25.03.93 Grafenwöhr DEH Geb. 433

VERFASSER:
H. Riefke

TEILNEHMER:
siehe Teilnehmerliste

GEGENSTAND DER BESPRECHUNG:

ERLEDIGUNG DURCH/BIS

35 %-Vorlage - Presentation and Review Conference

Mr. Marstiller stellt das Projekt vor und erläutert, wie die Energy Conservation Opportunities (ECO) - Energieeinsparungsmöglichkeiten - ausgearbeitet werden und mit welchem Formular die Bearbeitung sinnvoll ist.

Außerdem fragt Mr. Marstiller nach weiteren Informationen bezüglich dem Geräteeinsatz in der Küche. Er bittet die Ingenieure vom DEH um Angaben zum Einsatz der Geräte, z. B. Spülmaschine, pro Tag.

Von den Reviewern liegen noch keine Kommentare vor, da sie von Chief-Utility nur je einen Ordner bekommen haben und nicht, wie vorgesehen, je einen Satz, bestehend aus drei Ordnern.

Nachdem ihnen nun diese Unterlagen komplett vorliegen, werden sie die Prüfung bis Mitte April abgeschlossen haben und über EDE Baker und Gehrmann zustellen.

Da bisher den Planern die Verbrauchswerte der Kantinen nur für die Sommermonate zur Verfügung standen, wurden für Grafenwöhr die Ablesungen direkt in den Zentralen von GC mit Stand 25.03.93 für Elektro und Heizung vorgenommen, so daß eine detailliertere Überprüfung möglich ist. Für Vilseck werden diese Informationen von Frau Rieger direkt GC zugeschickt.

AKTENVERMERK

GESPRÄCHSBESTÄTIGUNG

DATUM: 25.03.93

PROJ. NR.: 4240

SEITE 2

ERLEDIGUNG DURCH/BIS

Vom DEH erhielt GC die Verbrauchskosten für Heizung und Strom für die gesamten Liegenschaften Grafenwöhr und Vilseck.

Von Mr. Wolner wird GC in ca. zwei Wochen die Entscheidung erhalten, ob gemäß GC-Schreiben vom Dezember 1992 statt der Messungen (im Vertrag mit EDE enthalten) die Lieferverträge der Versorgungsträger (Heizung und Elektro) für Grafenwöhr und Vilseck auf ihre Wirtschaftlichkeit hin untersucht werden sollen. Nach Aussage von Herrn Maier, DEH Grafenwöhr, wurden die Verträge GC bereits übergeben. Falls dies nicht der Fall sein sollte, muß Herr Repper um nochmalige Übersendung gebeten werden. Die Verträge für Vilseck wurden für GC nochmals kopiert.

Die 95 %-Vorlage soll bis Mitte Mai EDE von Baker übergeben werden, so daß Anfang Juni die abschließende Präsentation stattfinden kann.

(Riefke)

Best.-Nr. 120

03.04.93 13:04

U.S. Army Corps of Engineers
Europe District

Conference Sign-In Sheet

Project Title: ENERGY AUDIT DINING FACILITIES

Type of Conference: 35 % SUBMITTAL REVIEW

Conference Initiator: EUD

Date: 25 Mar 93 Time: 0930 Location: 100th ASG GRAFENWOEHR

The Gateway to Excellence in Engineering

Name: First Last	Position/ Title	Organization and Address	Office Phone / Fax Phone
WOLNER, LINDY	PROJECT MANAGER	CETAE-PM-ME, UNIT #25727 APO AE 09242	069-151-7318 069-596-4729
LERIAN, WALTER	MANAGER	BAKER & ASSOC 420 ROUSER RD CORAOPOLIS, PA 15108	412-269-6877
MARTINEAC, TED	SR. ENGINEER	BAKER & ASSOC.	412-269-6246 412-269-6097
RIEFKE, WOLFGANG	PROJECT MANAGER	GEHRMANN CONSULT	0611 717600
Lehnig Heinz	Elektro	Gehrmann Consult	0611/717337
Inge Spät	[illegible]	[illegible]	475-6134
STEVE DUNHAM	UTILITIES CHIEF	100th DEH	475-7170 FAX 7391
Roland Repper	Energy Coord. 409th	DEH, 409th BSB Grafenwöhr	475-7144
Elfriede Rieger	Energy Coord. Vilseck	DEH, 281st BSB Vilseck	476-2944

Monatsdaten Gebäude #101
(Cons. Dining Fac. Graf)

Datum	Stromzähler (KWh)	Wärmemenge (m^3)	Wärmemenge (MWh)
'0-4-92	18.376,3	418070	01837,6
' 5-92	18842,3	437212	01928,2
Verbrauch (May 92)	466,–	19142	90,6
29-6-92	19193,7	450.953	01964,0
Verbrauch (Jun 92)	351,4	13.741	35,8
31,07,92	19628,4	465.758	02002,4
Verbrauch (Jul 92)	434,7	14.805	38,4
31.08.92	20,086,3	478,982	02047,6
Verbrauch (Aug 92)	457,9	13.224	45,2
3 - .09.92	20,478,8	491.836	02105,2
Verbrauch (Sep 92)	392,5	12.854	57,6
30.10.92	20.876,3	505.823	02205,8
Verbrauch (Oct 92)	397,5	13.987	100,6
30.11.92	21.314,9	521.912	02321,9
Verbrauch (Nov 92)	438,6	16.089	116.1
25.03.93	22 883.8	577.760	02773,2

1568.9 : 4
332,2

MONTHLY METER READING

BUILDING 603

VILSECK

DATE	ELECTRICITY METER KWH	HEATING METER MWH	COMPLETED BY
4 MAY 30 APR 92	16 086 (x 250)	~~486 715~~ 7106.5	Rümpler/Ringl
01 JUN 92	16 310 (x 250)	~~492 206~~ 7763	/Ringl
30 JUN 92	16 560 (x 250)	8084	/Ringl
31 JUL 92	–	8142	
31 AUG 92	17 078 (x 250)	8187	
30 SEP 92	17 298 (x 250)	8337	
30 NOV 92	–	8491	
31 MAR 93	18 883 (x 250)	9171	

PURPOSE: USAREUR DINING FACILITY STUDY 1992

Card NO.:	0001-1987	Delivery:	HIGH TENSION N	Supplier:	OBAG
Service Location:	GRAFENWOEHR-EAST-CAMP	Contract No:	DAJA04-88-D-0030	Permitted PF:	0.9
Contract Demand:	5000 KW	Min Demand:	2800 KW	Max Demand:	6300 KW
Main Trans Cap:	SEE TRANS LIST	Metering Fee:	14.00 DM	Rent	
		Next:		Next:	
Dem Chrg:	ALL 232.80 DM	Next:		Next:	ALL 11.4 PF/KWH
Eng Chrg HT:	1ST MIO 11.7 PF/KWH	Next:	10 MIO 11.7 PF/KWH	Next:	ALL 9.2 PF/KWH
Eng Chrg NT:	1STO.6 MIO 9.4PF/KWH	Next:	6 MIO 9.4 PF/KWH	Next:	
Rct Chrg:	ALL 0.037 DM	Next:			

Remarks: MAIN STATION: DEMAND 10 ALL FURTHER 8000

MO	KW	ON-PEAK	OFF-PEAK	TOTAL KWH	UTIL	REACTIVE	PF	DEM.CH.	ACT.COST	PF-COST	FEES	TOT.COST	AVG
Ja	4596.90	1404340	1112310	2516650	547	404290	0.987	96000.00	256150.54	0.00	42.00	352192.54	0.140
Fe	4283.20	1351010	912305	2263315	473	398350	0.985	96000.00	228657.15	0.00	42.00	324699.15	0.143
Ma	3851.00	1201605	788625	1990230	517	265300	0.991	96000.00	201387.73	0.00	42.00	297429.73	0.149
Ap	4323.30	859815	1532435	2392250	553	386830	0.987	96000.00	228331.41	0.00	42.00	324373.41	0.136
My	3610.00	774755	1100035	1874790	519	303120	0.987	96000.00	181313.48	0.00	42.00	277355.48	0.148
Jn	3384.00	708690	1027580	1736270	513	194605	0.994	96000.00	167709.71	0.00	42.00	263751.71	0.152
Jl	3774.70	801590	1135640	1937230	513	272990	0.990	96000.00	187376.38	0.00	42.00	283418.38	0.146
Au	3813.80	812085	1106845	1918930	503	311600	0.987	96000.00	186030.91	0.00	42.00	282072.91	0.147
Se	3412.90	719205	897785	1616990	474	161290	0.995	96000.00	157579.45	0.00	42.00	253621.45	0.157
[illegible]	4399.80	1296875	996130	2293105	521	389285	0.986	96000.00	229979.05	0.00	42.00	326021.05	0.142
No	4581.80	1306585	977515	2284100	499	475885	0.979	96000.00	229421.45	0.00	42.00	325463.45	0.142
De	4113.40	1173175	984430	2157605	525	333590	0.988	96000.00	148580.45	0.00	42.00	244622.45	0.113
TO	4053.73	12409830	12571635	24981465	6163	3897095	0.988	1152000.00	2402517.71	0.00	504.00	3555021.71	0.142

1 9 9 2

Verbrauchswerten Heizung

CONTRACT #: DAJA04-87-D-0075 SUPPLIER: Fränkische Gaslieferungsgesellschaft

CONTRACT DEMAND: 30 MW PRESSURE/TEMPERATURE: 160° W/100° S

SERVICE LOCATION: Grafenwoehr East Camp

METER RENTAL CHARGES: According to Para 3.2. of contract APR MINIMUM: 60 % = 32,400 MWH LPR MINIMUM: 70 % = 294 MWH

REPAY OF INVESTMENT: 142,750.00 DM per month METER FEE: 760.00 DM per month USE PER DAY: 14 hrs

DEMAND CHARGE: 339,428 PF per KWM * ENERGY CHARGE: 45,324 DM per MWH *

* DM-Amounts within this positions are depending from the Annual Demand Charges and the Work Price of the "Price Adjustment Clause" Paragraph § 5 of the contract.

	ENERGY USE MWH	DEMAND CHARGE	ENERGY CHARGE	REPAY OF INVESTMENT	METER FEE	TOTAL COST	AVERAGE COST / MWH
JANUARY	6,578.30	83,159.86	182,024.00	142,750.00	760.00	408,693.86	62.13
FEBRUARY	6,807.80	83,159.86	182,024.00	142,750.00	760.00	408,693.86	60.04
MARCH	5,512.00	83,159.86	182,024.00	142,750.00	760.00	408,693.86	74.15
APRIL	5,294.41	83,159.86	190,268.00	142,750.00	760.00	416,937.86	78.76
MAY	4,610.37	83,159.86	190,268.00	142,750.00	760.00	416,937.86	90.44
JUNE	2,271.82	83,159.86	190,268.00	142,750.00	760.00	416,937.86	183.53
JULY	1,410.43	83,159.86	182,096.00	142,750.00	760.00	408,765.86	289.82
AUGUST	1,386.09	83,159.86	182,096.00	142,750.00	760.00	408,765.86	294.91
SEPTEMBER	1,174.52	83,159.86	182,096.00	142,750.00	760:00	408,765.86	348.03
OCTOBER	1,814.66	85,850.45	87,727.89	142,750.00	760.00	317,088.34	174.73
NOVEMBER	4,510.20	85,850.45	173,420.00	142,750.00	760.00	402,780.45	89.30
DECEMBER	4,826.80	85,850.45	173,420.00	142,750.00	760.00	402,780.45	83.44
TOTAL	46,197.40	1,005,990.09	2,097,731.89	1,713,000.00	9,120.00	4,825,841.98	104.46

SERVICE LOCATION: VILSECK SOUTH CAMP

METER RENTAL CHARGES: [illegible]

REPAYMENT OF INVESTMENT: [illegible]

DEMAND CHARGE: [illegible]

MONTH		ANNUAL DEMAND CHARGE					
JANUARY	10809.27	110879.81	257530.00	310576.58	1749.00	680735.39	62.98
FEBRUARY	11365.46	110879.91	257530.00	310576.58	1749.00	680735.39	59.90
MARCH	9458.00	110879.81	257530.00	310576.58	1749.00	680735.39	71.97
APRIL	6949.06	110879.81	267855.00	310576.56	1749.00	691040.39	77.22
MAY	6601.80	110879.81	267835.00	310576.58	1749.00	691040.39	104.67
JUNE	3721.30	110879.81	267855.00	310576.58	1749.00	691040.39	185.70
JULY	2085.99	110879.81	257620.00	310576.58	1749.00	680825.39	326.38
AUGUST	1942.78	110879.81	257620.00	310576.58	1749.00	680825.39	350.44
SEPTEMBER	1664.65	180802.02	1081373.90	310576.58	1749.00	1574501.50	945.85
OCTOBER	2879.37	120482.64	320807.50	310576.58	1749.00	753615.72	261.73
NOVEMBER	7593.48	120482.64	320807.50	310576.58	1749.00	753615.72	99.25
DECEMBER	8576.87	120482.64	320807.50	310576.58	1749.00	753615.72	87.87
TOTAL	75648.03	1429286.42	4135131.40	3726918.96	20988.00	9312326.78	123.10

Card NO.: 0070-1987
Service Location: VILSECK SOUTH CAMP
Contract Demand: 4560 KW 5500
Contract No.:
Min Demand: 1520 KW
Metering Fee: 42.0 DM/PE
Max Demand: 4500 KW
Main Trans Cap: SEE TRANS LIST
Dem Chrg: ALL 230.00 DM
Eng Chrg OP: 1ST MIO 11.05 PF/KWH Next: 10 MIO 11.05 PF/KWH Next: ALL 11.05 PF/KWH
Eng Chrg NT: 1ST 0.6 MIO 8.7 PF/KWH Next: 6 MIO 8.7 PF/KWH Next: ALL 8.7 PF/KWH
Rea Chrg: ALL 0.0370 DM

Remarks: METER CONST: DEMAND 1, ALL FURTHER 4000

MO	KW	ON-PEAK	OFF-PEAK	TOTAL KWH	UTIL	REACTIVE	PF	DEM.Ch	ACT.COST	PF COST	FEES	TOT.COST	AVG
Ja	5392.00	1659800	1363040	3022840	561	268800	0.996	96000.CO	304193.36	0.00	56.00	402248.38	0.133
Fe	5152.00	1341560	1080480	2422040	509	258050	0.995	96000.00	264344.14	0.00	56.00	360400.14	0.137
Me	5192.00	1670440	1087920	2758360	531	316080	0.993	96000.00	279232.66	0.00	56.00	375288.66	0.136
Ap	5248.00	1032760	1814560	2847320	543	321680	0.994	96000.00	273961.17	0.00	56.00	370017.17	0.130
My	4808.00	902160	1312400	2214560	461	277840	0.992	96000.00	213867.46	0.00	56.00	309923.48	0.140
Ju	4728.00	919400	1383080	2302480	487	191640	0.997	96000.00	221921.66	0.00	56.00	317977.66	0.138
Jl	4256.00	949440	1390760	2340200	550	157640	0.998	96000.00	225909.24	0.00	56.00	321965.24	0.138
Au	4724.00	892920	1233040	2125960	503	160000	0.997	96000.00	205942.14	0.00	56.00	301998.16	0.142
Se	4664.00	995160	1310800	2305960	494	258680	0.994	96000.00	224004.76	0.00	56.00	320060.78	0.139
Oc	5304.00	1639720	1246620	2886240	544	430480	0.989	105600.0	289636.30	0.00	56.00	395292.30	0.137
No	5576.00	1600000	1185600	2785600	500	445600	0.987	105600.C	279947.20	0.00	56.00	385603.20	0.138
De	5576.00	1772920	1534480	3307400	593	435440	0.991	105600.0	440023.24	0.00	56.00	545679.24	0.165
TO	5010.00	15576280	15942680	31518960	6291	3522160	0.991	1180800.00	3224982.39	0.00	672.00	4406454.39	0.140

APPENDIX C

ENERGY CONSERVATION

OPPORTUNITY (ECO) CHECKLIST

ENERGY CONSERVATION OPPORTUNITY (ECO) CHECKLIST

ARCHITECTURAL ECO's

Architectural Energy Conservation Opportunities (ECO's) consist, mainly of those ECO's which will improve the thermal efficiency of the building envelope. The following twelve architectural ECO's were investigated at both the Grafenwöhr and the Vilseck sites.

A1. Conserve energy by increasing the insulation in exterior walls.

A2. Conserve energy by adding roof or ceiling insulation to the building to achieve a thermal resistance (R) rating of at least R-30 for the combined ceiling elements.

A3. Conserve energy by reducing the amount of window glass in exterior walls.

A4. Conserve energy by installing insulated panels over exterior windows.

A5. Conserve energy by replacing single pane window glass with double or triple pane window glass.

A6. Conserve energy by installing storm windows over exterior windows.

A7. Conserve energy by installing solar film on exterior windows.

A8. Conserve energy by installing shades, screens, curtains or blinds on exterior windows.

A9. Conserve energy by reducing infiltration by means of new or improved weatherstripping and/or caulking.

A10. Conserve energy by installing vestibules at troop entrances.

A11. Conserve energy by installing air curtains or plastic strips at all service entrances.

A12. Conserve lighting energy by improving the reflectivity of room surfaces.

HVAC SYSTEM ECO's

Heating, Ventilating, and Air Conditioning (HVAC) system ECO's consist of changes which will improve the efficiency of the HVAC System (i.e. - air handling units, exhaust fans, piping, ductwork, etc.) and the HVAC system controls. The following twenty-five HVAC system ECO's were investigated at both the Grafenwöhr and the Vilseck sites.

H1. Conserve energy by installing energy efficient exhaust hoods with integral make-up air ducts.

H2. Conserve energy by recovering waste heat from exhaust air streams.

H3. Conserve energy by changing constant volume air handling units to variable air volume (VAV) operation.

H4. Conserve energy by balancing the HVAC system.

H5. Conserve energy by reducing the amount of air supplied to or exhausted from the building (or space).

H6. Conserve energy by reducing the amount of ventilation air drawn into the building by the HVAC system.

H7. Conserve energy by installing tight-closing, low-leakage dampers on all outside air intake and exhaust openings (except at kitchen exhaust fans since damper blades could collect grease and become a fire hazard).

H8. Conserve energy by reducing static pressure in HVAC systems.

H9. Conserve energy by reducing supply air leakage at air handling units and supply air ductwork.

H10. Conserve energy by insulating and/or repairing damaged insulation on HVAC system ductwork.

H11. Conserve energy by installing ceiling-mounted circulating fans to reduce stratification within occupied spaces.

H12. Conserve energy by recovering waste heat from refrigeration systems.

H13. Conserve energy by ventilating the refrigeration system compressor room.

H14. Conserve energy by replacing reciprocating type refrigeration compressors with higher efficiency scroll or rotary (screw) type compressors.

H15. Conserve energy by re-setting heating hot water temperature according to outside air temperature and occupancy schedules.

H16. Conserve energy by reducing pump flow rates.

H17. Conserve energy by installing new insulation, adding additional insulation, or repairing existing insulation on heating hot water piping.

H18. Conserve energy by repairing or eliminating all HVAC system control deficiencies.

H19. Conserve energy by using the Energy Monitoring and Control System (EMCS) to optimize the start-up and shut-down schedules for HVAC system fans, pumps, compressors, and other motorized devices.

H20. Conserve energy by using the EMCS to set-back space temperatures at night during the heating season.

H21. Conserve energy by installing occupancy sensors to cycle the ventilation system "on" and "off" according to occupancy.

H22. Conserve energy by interlocking the kitchen exhaust hoods with the cooking equipment served by each hood.

H23. Conserve energy by installing economizer cycle controls and dampers on all ventilation systems.

H24. Conserve energy by shutting off or reducing the amount of heating in vestibules.

H25. Conserve energy by installing a thermal storage system.

H26. Conserve energy by using infrared heaters in lieu of conventional (convection) heaters.

PLUMBING SYSTEM ECO's

Plumbing System ECO's consist of changes which will improve the efficiency and/or reduce the energy consumption of the plumbing systems (i.e. - Domestic cold water, hot

water and waste water systems). The following ten plumbing ECO's were investigated at both the Grafenwöhr and Vilseck sites.

P1. Conserve energy by lowering the domestic hot water supply temperature.

P2. Conserve energy by installing controls on the domestic hot water system to lower the heater's set-point temperature or to shut-off the heat source to the heater during non-peak periods.

P3. Conserve energy by installing booster heaters at major hot water users and at high temperature hot water users.

P4. Conserve energy by installing instantaneous hot water heaters in lieu of storage tank type heaters.

P5. Conserve energy by installing additional insulation on the domestic hot water storage tanks.

P6. Conserve energy by installing additional insulation and/or repairing existing insulation on domestic hot water piping.

P7. Conserve energy by installing flow restrictors at domestic hot and cold water end users.

P8. Conserve energy by installing automatic shut-off type faucets in lavatories.

P9. Conserve energy by reclaiming waste heat from dishwasher wastewater.

P10. Conserve energy by installing solar collectors to pre-heat domestic hot water.

ELECTRICAL SYSTEM ECO's

Electrical System ECO's consist of changes which will improve the efficiency and/or reduce the energy consumption of the electrical system (i.e. - power distribution and lighting systems). The following twenty electrical ECO's were investigated at both the Grafenwöhr and the Vilseck sites.

E1. Conserve energy by reducing lighting levels to minimum levels described in the Army Design Guidelines.

E2. Conserve lighting energy by eliminating excess fixtures. Where fixtures are close enough to each other, it may be possible to eliminate excess fixtures without creating dark spots.

E3. Conserve energy by delamping selected lighting fixtures.

E4. Conserve energy by converting existing lighting fixtures to high efficiency fluorescent or HID fixtures.

E5. Conserve energy by replacing the incandescent lamps in exit lights with lower wattage fluorescent lamps.

E6. Conserve energy by installing improved reflectors on lighting fixtures and reducing the fixtures lamp wattage.

E7. Conserve energy by replacing existing core coil ballasts with electronic ballasts in existing fluorescent lighting fixtures.

E8. Conserve energy by replacing existing lamps with energy efficient U-tube fluorescent lamps.

E9. Conserve energy by replacing existing incandescent bulbs with compact fluorescent bulbs.

E10. Conserve energy by installing dimming hardware on exterior HID lighting.

E11. Conserve energy by turning exterior lighting "on" and "off" by means of photocells.

E12. Conserve energy by turning exterior lighting "on" and "off" by means of timers.

E13. Conserve energy by providing task level switching for interior lights. Task level switching will allow the lighting level to be varied to match the activity within the space.

E14. Conserve lighting energy by using photocells to turn "off" or dim interior lights (especially lights near windows) when natural daylight provides adequate illumination.

E15. Conserve energy by turning interior lighting "on" and "off" by means of timers.

E16. Conserve energy by turning interior lighting "on" and "off" by means of space occupancy sensors.

E17. Conserve energy by replacing existing motors with energy efficient motors.

E18. Conserve energy by replacing oversized/undersized motors with motors which have their peak efficiency at the actual system load.

E19. Conserve energy by adding power factor correcting capacitors to existing motors.

E20. Conserve energy by equipping motors which experience highly variable loads with variable frequency drives.

OPERATIONS AND MAINTENANCE ECO's

Operations and Maintenance (O & M) ECO's consist of changes to the procedures which govern the use and maintenance of the dining facility and the equipment therein. Most O & M ECO's can be classified as Low/No Cost ECO's and are, therefore, of special interest to the facility managers and users. Many O & M ECO's may be put into effect by installing time clock controls at some later date, however, all of the proposed O & M ECO's can be put into effect immediately, through the efforts of the kitchen and maintenance staffs. The following twenty-one O & M ECO's have been investigated at both the Grafenwöhr and Vilseck sites.

OM1. Conserve energy by optimizing HVAC system start-stop times and set-back temperatures with respect to dining facility operations.

OM2. Conserve energy by maintaining thermostat set-points at authorized temperatures.

OM3. Conserve energy by turning "off" kitchen hot water heaters (specifically booster heaters on dishwashing equipment) when not required.

OM4. Conserve energy by shedding or cycling electrical loads to reduce peak demand.

OM5. Conserve energy by running the emergency generator to reduce peak demand.

OM6. Conserve energy by maintaining all HVAC system controls in good working order.

OM7. Conserve energy by keeping the coils (both evaporator and condenser) on all refrigeration equipment clean and unobstructed.

OM8. Conserve energy by keeping the heat exchanger tubes in the domestic hot water heater clean. Provide water treatment if required to prevent fouling of tube surfaces.

OM9. Conserve energy by keeping all light fixture lenses and reflectors clean.

OM10. Conserve energy by keeping all HVAC system filters (including exhaust hood grease filters) clean.

OM11. Conserve energy by turning "off" all miscellaneous electrical equipment (such as vending machines) whenever it is not required.

OM12. Conserve energy by consolidating refrigerated foodstuffs into fewer refrigerators, coolers, or freezers and turning "off" those freezers that are not required.

OM13. Conserve energy by thawing frozen foods in refrigerated compartments.

OM14. Conserve energy by preheating only that equipment which will be required for the meal being served.

OM15. Conserve energy by preheating equipment immediately prior to use.

OM16. Conserve energy by steaming (rather than boiling) vegetables whenever possible.

OM17. Conserve energy by matching pots to burner size so that pots completely cover burners.

OM18. Conserve energy by cooking with lids in place.

OM19. Conserve energy by using microwave cooking equipment in lieu of conventional cooking equipment whenever possible.

OM20. Conserve energy by avoiding the use of hot water for dish scraping.

OM21. Conserve energy by operating dishwashers only when continuous usage can be sustained.

OM22. Conserve energy by reducing the building's operating hours.

OM23. Conserve energy by conducting regular steam trap inspections.

APPENDIX D

ECO's ELIMINATED

1.0 ECO's Rejected for Grafenwöhr Building 101

1.1 In some instances ECO's were rejected without a formal, cost vs. benefits analysis. Engineering experience and/or the particular situation or installation at Grafenwöhr Building 101 indicated that these ECO's were either impractical or impossible to install at this site. All of the ECO's rejected on this basis are listed below. An explanation of the basis for rejection follows the ECO description.

A1 Conserve energy by increasing the insulation in exterior walls.

Building 101 was designed with 6 centimeters of fiberglass batt insulation in the wall cavity between the outer brick wythe and the inner concrete block wythe of the exterior wall. This exceeds the 5cm of insulation required by the "Standard Design Guidelines for Modifying Interior and Exterior Energy Systems" published by the Utilities and Energy Branch HQ, USAREUS. See Table 1-1. Additional insulation would have only a marginal effect on the thermal characteristics of the exterior walls and would be enormously expensive since it would have to be installed on either the exterior of the building (using a system similar to the Dryvit system) or on the interior surface of the existing plaster wall. The new interior insulation would, then, have to be covered with new wood paneling and/or a new gypsum board interior wall.

A2 Conserve energy by adding roof or ceiling insulation to the building to achieve a thermal resistance (R) rating of at least R-30 for the combined ceiling elements.

Building 101 was designed with 12cm of rigid board roof insulation. Assuming that the insulation is a typical, expanded polystyrene board (R=5.0/inch), the R-value of the roof assembly is estimated to be 25.18 °F-ft^2-hr/BTU. Increasing the R-value of the roof from the present R-25 to R-30 would have only marginal impact on the roof's thermal characteristics. Because the roof is only ten years

old, the cost of re-roofing would more than offset any thermal improvement. However, when re-roofing is required, the roof insulation should be increased to achieve a rating of R-30 for the roof assembly.

A3 Conserve energy by reducing the amount of window glass in exterior walls

As presently configured, Building 101 has a glass-to-wall ratio of only 7.0 percent. There is little reason to reduce this ratio even further. The only significant amount of glazing in the building is in the dining area. Reducing this glass area further would reduce the architectural attractiveness of the dining space and the amount of daylight which enters the building. See ECO E14.

A4 Conserve energy by installing insulated panels over exterior windows

See commentary on ECO A3.

A5 Conserve energy by replacing single pane window glass with double or triple pane window glass.

The existing windows are already glazed with double pane, insulating window glass. Increasing the thermal efficiency of the windows by installing triple pane glass would only have a marginal effect on the thermal efficiency of the building.

A6 Conserve energy by installing storm windows over exterior windows.

See commentary on ECO A5.

A7 Conserve energy by installing solar film on exterior windows.

During the summer months, solar film does an excellent job of limiting solar heat gain and reducing the air conditioning load. However, since Building 101 is not air conditioned, solar film would have little energy conserving benefit. During the winter months, the lack of solar film (existing condition) allows solar energy to enter the dining area. This tends to reduce the amount of heating required to keep the dining area comfortable. In this case, the lack of solar film is a benefit.

A8 Conserve energy by installing shades, screens, curtains, or blinds on exterior windows.

The windows at Grafenwöhr Building 101 are already outfitted with interior curtains. See, also, commentary on ECO A7.

A9 Conserve energy by reducing infiltration by means of new or improved weatherstripping and/or caulking.

The weatherstripping and caulking on Building 101 was found to be in good condition.

A10 Conserve energy by installing vestibules at troop entrances.

Building 101 is already equipped with an entry vestibule at the troop entrance. Exterior doors not equipped with vestibules are all marked with "Emergency Exit Only" signs.

A11 Conserve energy by installing air curtains or plastic strips at all service entrances.

Current practice at Building 101 is to leave the kitchen make-up air unit "off" even when the kitchen hood exhaust fans are turned "on". This is done in all but the coldest weather. Since the units supplying make-up air to the kitchen and the dining area are not turned on, the make-up air for the exhaust hoods is drawn into the building through the screened rear (service entrance) doors. Since this practice seems to work satisfactorily, it is likely to be continued. Therefore, an air curtain or plastic door strips, which would reduce the amount of air infiltrating into the building would be undesirable. Since the amount of outside air drawn into the building is the same, whether it is infiltration or ventilation air supplied by the make-up air units, the building's energy consumption remains constant. During extremely cold weather, the kitchen ventilation unit is turned "on" and the rear entry doors are kept closed. So air curtains or door strips would be of little use under this condition, also.

A12 Conserve lighting energy by improving the reflectivity of room surfaces.

Wall and ceiling surfaces at Grafenwöhr Building 101 were found to be of a light color and kept clean. Therefore, there is little opportunity for conserving energy by improving surface reflectivity.

H1 Conserve energy by installing energy efficient exhaust hoods with integral make-up air ducts.

Energy saving exhaust hoods are already installed in Building 101.

H2 Conserve energy by recovering waste heat from exhaust air streams.

The energy-saving exhaust hoods installed in Building 101 (See commentary on ECO H1) have exhaust air streams with a very low heat content since most of the air being exhausted is outdoor air. For this reason, there is very little potential for exhaust air heat recovery. The toilet room exhaust has a somewhat higher heat content (higher temperature) but it has a very low flow rate and a low number of operating hours. Therefore, the potential for heat recovery from toilet room exhaust is, also, very low.

H3 Conserve energy by changing constant volume air handling units to variable air volume (VAV) operation.

Because two of the air handling units (kitchen and serving line units) are rarely turned on and because the building is not air conditioned, there is little or no potential energy savings expected from converting to VAV operation. VAV operation is particularly effective in reducing energy consumption when the HVAC system is operating in the air conditioning mode. However, it is not particularly effective in reducing energy consumption during the heating season. This is due to the fact that building heating is accomplished, primarily, through the perimeter radiation system.

H4 Conserve energy by balancing the HVAC system.

There were no unexpected or extreme temperature variations within the dining areas of Building 101. This indicates that the air supplied to the area is well suited to the requirements of that space. (Note that under normal operating conditions, only the air handling unit supplying the dining area is used). Therefore, it appears that the HVAC system does not require re-balancing.

H5 Conserve energy by reducing the amount of air supplied or exhausted from the building (or space).

An investigation of the existing drawings suggests that the present air flow rates are at or below the DIN requirements and the VDI guidelines. However, since the supply and exhaust air quantities of the existing HVAC system appear to be satisfactory for both comfort and odor control, there is little reason to re-balance the system.

H6 Conserve energy by reducing the amount of ventilation air drawn into the building by the HVAC system.

As noted previously, the air handling units serving the kitchen and the serving area are rarely used. Therefore, no energy savings can be derived from reducing the ventilation air flow rate of these units. The outdoor air damper on the dining area air handling unit appears to be operating properly to control the amount of ventilation air being supplied to the space and to minimize energy consumption.

H7 Conserve energy by installing tight-closing, low-leakage dampers on all outside air intake and exhaust openings (except at kitchen exhaust fans since damper blades could collect grease and become a fire hazard).

Low-leakage dampers are already present on the air handling equipment installed in Building 101.

H8 Conserve energy by reducing static pressure in HVAC systems.

The air handling unit serving the dining area appears to be operating satisfactorily. (See commentary on ECO H4). Since the system is a constant volume system, there are no VAV boxes which require some additional minimum static pressure at the box inlet. Therefore, the system static pressure is already at or near its optimum setting.

H9 Conserve energy by reducing supply air leakage at air handling units and supply air ductwork.

There were no large or obvious leaks in the visible portions of the supply air ductwork or at the air handling unit casings at Building 101.

H10 Conserve energy by insulating and/or repairing damaged insulation on HVAC system ductwork.

The insulation on the visible portions of the HVAC system ductwork in Grafenwöhr Building 101 appeared to be intact and in good repair. Only minor repairs are required where the vapor barrier (external skin) of the insulation has been punctured or where seam tape has come unglued.

H11 Conserve energy by installing ceiling-mounted circulating fans to reduce stratification within occupied spaces.

The ceilings in Building 101 are between 2.99m. and 3.25m. high. These ceilings are too low for the interior spaces to have serious stratification problems. They are also somewhat low to have surface mounted recirculation fans installed below them.

H12 Conserve energy by recovering waste heat from refrigeration systems.

The most effective way to capture waste heat from refrigeration systems is to use a heat exchanger to preheat domestic hot water with the refrigerant hot gas. However, because the domestic hot water storage tank temperature (60°C) is greater than the hot gas temperature (± 43°C) of the refrigerator/freezer refrigeration systems, an additional hot water storage tank would have to be installed to allow heat to be recovered from the food storage refrigeration equipment. This tank would be used to pre-heat domestic water before it entered the existing hot water storage tank. However, there is not enough space in either the mechanical room or the refrigeration compressor room for such a storage tank.

H13 Conserve energy by ventilating the refrigeration system compressor room.

The compressor room in Building 101 is already equipped with a ventilation system. This consists of an intake louver in the east wall of the room and a roof-mounted exhaust fan.

H14 Conserve energy by replacing reciprocating type refrigeration compressors with higher efficiency scroll or rotary (screw) type compressors.

Given the age of Building 101 and the installed equipment, replacement of the refrigeration compressors would be impractical for two reasons. One, the equipment is less than half way through its useful life; and, two, the installed equipment should have a relatively high coefficient-of-performance (COP).

H15 Conserve energy by re-setting heating hot water temperature according to outside air temperature and occupancy schedules.

The building automation system installed in Building 101 is already programmed to perform these functions.

H16 Conserve energy by reducing pump flow rates.

The building automation system installed in Building 101 is already programmed to adjust hot water flow rates - using the installed variable speed Wilo pumps - to suit the building's loads.

H18 Conserve energy by repairing or eliminating all HVAC control deficiencies.

According to building operating personnel, the installed building controls are operating properly.

H19 Conserve energy by using an Energy Monitoring and Control System (EMCS) to optimize the start-up and shut-down schedules for HVAC system fans, pumps, compressors, and other motorized devices.

According to building operating personnel, the installed EMCS is presently used to optimize equipment performance and building comfort.

H20 Conserve energy by using an EMCS to set-back space temperatures at night during the heating season.

See commentary on ECO H19.

H21 Conserve energy by installing occupancy sensors to cycle the ventilation system "on" and "off" according to occupancy.

The occupancy schedule for this building is well defined. Therefore, the ventilation system can be controlled effectively by the EMCS and the addition of space occupancy sensors is unnecessary.

H22 Conserve energy by interlocking the kitchen exhaust hoods with the cooking equipment served by each hood.

It has been determined that re-wiring the existing cooking equipment to turn the associated exhaust hoods "on" and "off" is impractical. However, training the kitchen staff to operate cooking hoods only while cooking is a viable low/no cost ECO, and will be dealt with as an O&M ECO.

H23 Conserve energy by installing economizer cycle controls and dampers on all ventilation systems.

The air handling units in Building 101 are not equipped for air conditioning. Therefore, economizer cycle controls are not necessary.

H24 Conserve energy by shutting off or reducing the amount of heating in vestibules.

The only vestibule in Building 101 (at the troop entrance to the building) is not equipped with any heating devices.

H25 Conserve energy by installing a thermal storage system.

Thermal storage systems are only practical for buildings equipped with air conditioning. Even then they are only viable when there are significant time-of-day incentives (from the power supplier) for consuming more power during off-peak periods and less power during peak demand periods. Since neither of these criteria are met at Grafenwöhr, there is little reason to install a thermal storage system.

H26 Conserve energy by using infrared heaters in lieu of conventional (convection) heaters.

Infrared heaters are best suited for exterior area heating (such as loading docks) or for areas with extremely large volumes (such as warehouses). Since neither of these types of spaces are present in Building 101 there is little reason to pursue the use of infrared heating.

P1 Conserve energy by lowering the domestic hot water supply temperature.

The hot water storage temperature of 60°C is required by Army regulations.

P2 Conserve energy by installing controls on the domestic hot water system to lower the heater's set-point temperature or to shut-off the heat source to the heater during non-peak hours.

The required controls are already present on the Building 101 domestic hot water system.

P3 Conserve energy by installing booster heaters at major hot water users and at high temperature hot water users.

The largest, single hot water consumer is the dishwasher, which is already equipped with an electric booster heater.

P4 Conserve energy by installing instantaneous hot water heaters in lieu of storage tank type heaters.

Given the relatively recent construction of Building 101, the replacement of the existing water heating equipment with instantaneous water heaters is highly impractical. In addition, heating domestic water with electricity is more expensive (in both cost and energy terms) than heating with district hot water -as is presently done.

P6 Conserve energy by installing additional insulation and/or repairing existing insulation on domestic hot water piping.

The insulation for the domestic hot water system requiring repair is located in the central mechanical space. This insulation has been evaluated as part of ECO H17.

P9 Conserve energy by reclaiming waste heat from dishwasher wastewater.

The present dishwasher installation would make it extremely difficult to connect a water-to-water heat exchanger to the sanitary sewer connection on the dishwasher. Also, there is little space in the mechanical room for installing the additional pumps and secondary loop heat exchanger required to recover heat from the dishwasher wastewater.

P10 Conserve energy by installing solar collectors to pre-heat domestic hot water.

The total insolation (time and intensity of sunshine) in Grafenwöhr makes solar heating technically impractical.

E2 Conserve lighting energy by eliminating excess fixtures. Where fixtures are close enough to each other, it may be possible to eliminate excess fixtures without creating dark spots.

The lighting fixtures in Building 101 are spaced in such a manner that no fixtures can be eliminated without causing undesirable variations in the lighting levels within individual spaces.

E3 Conserve energy by de-lamping selected fixtures.

See ECO E1. In some areas, selective de-lamping, rather than re-lamping with lower wattage lamps, may be the most cost effective method for reducing lighting levels to the required minimum.

E4 Conserve energy by converting existing lighting fixtures to high efficiency fluorescent or HID fixtures.

Fixtures, both interior and exterior, at Grafenwöhr Building 101 are already either fluorescent (interior) or HID (exterior) type. Incandescent lighting is not used in this building.

E5 Conserve energy by replacing the incandescent lamps in exit lights with lower wattage fluorescent lamps.

This has already been done in Building 101.

E6 Conserve energy by installing improved reflectors on lighting fixtures and reducing the fixtures lamp wattage.

The lighting fixtures in Grafenwöhr Building 101 are relatively new fixtures which are already equipped with efficient reflectors and low wattage lamps.

E8 Conserve energy by replacing existing lamps with energy efficient U-tube fluorescent lamps.

For architectural reasons, the fixtures in Building 101 are not suitable for re-lamping with U-tube fluorescent lamps.

E9 Conserve energy by replacing existing incandescent bulbs with compact fluorescent bulbs.

See commentary on ECO E8.

E11 Conserve energy by turning exterior lighting "on" and "off" by means of photocells.

ECO E10 has been developed to minimize the energy used for exterior lighting. Photo cells have been included in the development of ECO E10.

E12 Conserve energy by turning exterior lighting "on" and "off" by means of timers.

ECO E10 has been developed to turn the exterior lighting "on" and "off" by means of a photocell. Therefore, this ECO will not be pursued. See, also, ECO E11.

E13 Conserve energy by providing task level switching for interior lights. Task level switching will allow the lighting level to be varied to match the activity within the space.

Because the Dining Facility is not a multiple use facility (i.e., the spaces are all designed for a single specific activity) task level switching is not appropriate for this building.

E15 Conserve energy by turning interior lighting "on" and "off" by means of timers.

ECO E14 has been developed to minimize energy usage within the Dining areas. Therefore, this ECO will not be pursued.

E16 Conserve energy by turning interior lighting "on" and "off" by means of space occupancy sensors.

ECO E14 has been developed to turn the interior lighting "on" and "off" by means of a timer. Therefore, this ECO will not be pursued. See, also, ECO E15.

E17 Conserve energy by replacing existing motors with energy efficient motors.

Given the relatively short period of time that the existing motors have been in service, it would be both expensive and wasteful to replace them with newer motors. In addition, the efficiency of newer motors is only marginally better than that of motors built less than ten years ago.

E18 Conserve energy by replacing oversized/undersized motors with motors which have their peak efficiency at the actual system load.

On inspection, the large (greater than 1/2 HP) motors at Grafenwöhr Building 101 were found to be well matched to their service loads.

E19 Conserve energy by adding power factor correcting capacitors to existing motors.

The motors on equipment installed in Building 101 are well suited for their service and do not require power factor correction.

E20 Conserve energy by equipping motors which experience highly variable loads with variable frequency drives.

The only motors which are subjected to this type of loading are the hot water pumps. These pumps are already equipped with variable frequency drives.

1.2 The following ECO was rejected after a rigorous investigation of its merits. Rejection was based on the ECO having a Savings-to-Investment Ratio (SIR) of less than 1.0. That is, the savings (in DM) generated by the ECO's would not even pay for the ECO's installation.

TABLE D-1 ECO's REJECTED - GRAFENWÖHR BUILDING 101

ECO NO.	ENERGY SAVINGS (MBTU/YR)*	FUEL **	COST SAVINGS (DM/YEAR)	COST (DM)	SIR	PAYBACK (YEARS)
E7	78.8	E	3,280	243,152	0.16	74.1

* MBTU = 10^6BTU'S
** Fuel types are: Electricity (E) and District Hot Water (DHW)

2.0 ECO's Rejected for Vilseck Building 603

2.1 The following ECO's were rejected for implementation at Vilseck Building 603 without the benefit of a formal cost vs. benefit analysis. The reason for the rejection follows the ECO description.

A1 Conserve energy by increasing insulation in exterior walls.

Building 603 was designed with 6 centimeters of fiberglass batt insulation in the wall cavity between the outer brick wythe and the inner concrete block wythe of the exterior wall. This exceeds the 5cm of insulation required by the "Standard Design Guidelines for Interior and Exterior Energy Systems" published by the Utilities and Energy Branch, HQ, USAREUS. See Table 1-1. Additional insulation would have only a marginal effect on the thermal characteristics of the exterior walls and would be enormously expensive since it would have to be installed on either the exterior of the building (using a system similar to the Dryvit system) or on the interior surface of the existing plaster wall. The new interior insulation would, then, have to be covered with new wood paneling and/or a new gypsum board interior wall.

A2 Conserve energy by adding roof or ceiling insulation to the building to achieve a thermal resistance (R) rating of at least R-30 for the combined ceiling elements.

Building 603 was designed with 12cm of fiberglass batt roof insulation. The R-value of the roof assembly is estimated to be 20.93 °F-ft^2-hr/BTU. Increasing the R-value of the roof from the present R-21 to R-30 would improve the roof's thermal characteristics, but would be very expensive. Because the roof is less than ten years old, the cost of re-roofing would more than offset any thermal improvement. However, when re-roofing is required, the roof insulation should be increased to achieve a rating of R-30 for the roof assembly.

A3 Conserve energy by reducing the amount of window glass in exterior walls

As presently configured, Building 603 has a low ratio of glass-to-wall. There is little reason to reduce this ratio even further. The only significant amount of glazing in the building is in the dining area. Reducing this glass area further would reduce the architectural attractiveness of the dining space.

A4 Conserve energy by installing insulated panels over exterior windows

See commentary on ECO A3.

A5 Conserve energy by replacing single pane window glass with double or triple pane window glass.

The existing windows are already glazed with double pane, insulating window glass. Increasing the thermal efficiency of the existing windows by installing triple pane glass would only have a marginal effect on the overall thermal efficiency of the building envelope.

A6 Conserve energy by installing storm windows over exterior windows.

See commentary on ECO A5.

A7 Conserve energy by installing solar film on exterior windows.

During the summer months, solar film does an excellent job of limiting solar heat gain and reducing the air conditioning load. However, since Building 603 is not air conditioned, solar film would have little energy conserving benefit. During the winter months, the lack of solar film (existing condition) allows solar energy to enter the dining area. This tends to reduce the amount of heating required to keep the dining area comfortable. In this case, the lack of solar film is a benefit.

A8 Conserve energy by installing shades, screens, curtains, or blinds on exterior windows.

The windows at Vilseck Building 603 are already equipped with interior curtains. See, also, commentary on ECO A7.

A9 Conserve energy by reducing infiltration by means of new or improved weatherstripping and/or caulking.

The weatherstripping and caulking on Building 603 was found to be in good condition.

A10 Conserve energy by installing vestibules at troop entrances.

Building 603 is already equipped with an entry vestibule at the troop entrance. Exterior doors not equipped with vestibules are all marked with "Emergency Exit Only" signs.

A11 Conserve energy by installing air curtains or plastic door strips at all service entrances.

Current practice at Building 603 is to have make-up air for the kitchen exhaust hoods brought into the building through the ventilation system. This keeps the building at a neutral pressure with the respect to the outdoors. Therefore, an air curtain or plastic door strips would do little to reduce the building's energy consumption.

A12 Conserve lighting energy by improving the reflectivity of room surfaces.

Wall and ceiling surfaces at Vilseck Building 603 were found to be of a light color and kept clean. Therefore, there is little opportunity for conserving energy by improving surface reflectivity.

H1 Conserve energy by installing energy efficient exhaust hoods with integral make-up air ducts.

Energy saving exhaust hoods are already installed in Building 603.

H2 Conserve energy by recovering waste heat from exhaust air streams.

The energy-saving exhaust hoods installed in Building 603 (See commentary on ECO H1) have exhaust air streams with a very low heat content since most of the air being exhausted is outdoor air. For this reason, there is very little potential for exhaust air heat recovery. The toilet room exhaust has a somewhat higher heat content (higher temperature) but it has a very low flow rate and a low number of operating hours. The dishwasher exhaust has an even greater total heat content, but an even lower number of operating hours. Therefore, the potential for heat recovery from the toilet room exhaust and the dishwasher exhaust is, also, very low.

H3 Conserve energy by changing constant volume air handling units to variable air volume (VAV) operation.

Because Building 603 is not air conditioned, there is little or no potential energy savings expected from converting to VAV operation. VAV operation is particularly effective in reducing energy consumption when the HVAC system is operating in the air conditioning mode. However, it is not particularly

effective in reducing energy consumption during the heating season. This is due to the fact that building heating is accomplished, primarily, through the perimeter radiation system.

H4 Conserve energy by balancing the HVAC system.

There were no unexpected or extreme temperature variations from area to area (or space to space) within Building 603. This indicates that the air supplied to each area (or space) is well suited to the requirements of that space. Therefore, it appears that the HVAC system does not require re-balancing.

H5 Conserve energy by reducing the amount of air supplied to or exhausted from the building (or space).

An investigation of the existing drawings suggests that the present air flow rates are at or below the DIN requirements and the VDI Guidelines. However, since the supply and exhaust air quantities of the existing HVAC system appear to be satisfactory for both comfort and odor control, there is little reason to re-balance the system.

H6 Conserve energy by reducing the amount of ventilation air drawn into the building by the HVAC system.

The outdoor air dampers on the air handling units in Building 603 appear to be operating properly to control the amount of ventilation air being supplied to the building interior. The HVAC system appears to be providing only the minimum amount of ventilation air required to make-up exhausted air and to ensure good air quality within the building.

H7 Conserve energy by installing tight-closing, low-leakage dampers on all outside air intake and exhaust openings (except at kitchen exhaust fans since damper blades could collect grease and become a fire hazard).

Low-leakage dampers are already present on the air handling equipment installed in Building 603.

H8 Conserve energy by reducing static pressure in HVAC systems.

The air handling units serving Building 603 appear to be operating satisfactorily. Since the HVAC system is a constant volume system, there are no VAV boxes which require some additional minimum static pressure at the box inlet. Therefore, the various HVAC systems are already operating at or near their optimum static pressure settings.

H9 Conserve energy by reducing supply air leakage at air handling units and supply air ductwork.

There were no large or obvious leaks in the visible portions of the supply air ductwork or in the air handling unit casings at Building 603.

H11 Conserve energy by installing ceiling-mounted circulating fans to reduce stratification within occupied spaces.

The ceilings in Building 603 are too low for the interior spaces to have serious stratification problems. They are also somewhat low to have surface mounted recirculation fans installed below them.

H12 Conserve energy by recovering waste heat from refrigeration systems.

The most effective way to capture waste heat from refrigeration systems is to use a heat exchanger to preheat domestic hot water with the refrigerant hot gas. However, because the domestic hot water storage tank temperature (60°C) is greater than the hot gas temperature (± 43°C) of the refrigerator/freezer refrigeration systems, an additional hot water storage tank would have to be installed to allow heat to be recovered from the food storage refrigeration equipment. This tank would be used to pre-heat domestic water before it entered the existing hot water storage tank. However, there is not enough space in either the mechanical room or the refrigeration compressor room for such a storage tank.

H13 Conserve energy by ventilating the refrigeration system compressor room.

The compressor room in Building 603 is already equipped with a ventilation system. This consists of an intake louver in the south wall of the room and a roof-mounted exhaust fan.

H14 Conserve energy by replacing reciprocating type refrigeration compressors with higher efficiency scroll or rotary (screw) type compressors.

Given the age of Building 603 and the installed equipment, replacement of the refrigeration compressors would be impractical for two reasons. One, the equipment is less than half way through its useful life; and, two, the installed equipment should have a relatively high coefficient-of-performance (COP).

H15 Conserve energy by re-setting heating hot water temperature according to outside air temperature and occupancy schedules.

The building automation system installed in Building 603 is already programmed to perform these functions.

H16 Conserve energy by reducing pump flow rates.

The building automation system installed in Building 603 is already programmed to adjust hot water flow rates - using the installed variable speed Grundfos pumps - to suit the building's loads.

H18 Conserve energy by repairing or eliminating all HVAC control deficiencies.

According to building operating personnel, the installed building controls are operating properly.

H19 Conserve energy by using an Energy Monitoring and Control System (EMCS) to optimize the start-up and shut-down schedules for HVAC system fans, pumps, compressors, and other motorized devices.

According to building operating personnel, the installed building control system is presently used to optimize equipment performance and building comfort. The building control system will be connected, shortly, to the site-wide EMCS.

H20 Conserve energy by using an EMCS to set-back space temperatures at night during the heating season.

See commentary on ECO H19.

H21 Conserve energy by installing occupancy sensors to cycle the ventilation system "on" and "off" according to occupancy.

The occupancy schedule for this building is well defined. Therefore, the ventilation system can be controlled effectively by the existing building control system. The addition of space occupancy sensors is unnecessary.

H22 Conserve energy by interlocking the kitchen exhaust hoods with the cooking equipment served by each hood.

It has been determined that re-wiring the existing cooking equipment to turn the associated exhaust hoods "on" and "off" is impractical. However, training the kitchen staff to operate cooking hoods only while cooking is a viable low/no cost ECO, and will be dealt with as an O&M ECO.

H23 Conserve energy by installing economizer cycle controls and dampers on all ventilation systems.

The air handling units in Building 603 are not equipped for air conditioning. Therefore, economizer cycle controls are not necessary.

H25 Conserve energy by installing a thermal storage system.

Thermal storage systems are only practical for buildings equipped with air conditioning. Even then they are only viable when there are significant time-of-day incentives (from the power supplier) for consuming more power during off-peak periods and less power during peak demand periods. Since neither of these criteria are met at Vilseck, there is little reason to install a thermal storage system.

H26 Conserve energy by using infrared heaters in lieu of conventional (convection) heaters.

Infrared heaters are best suited for exterior area heating (such as loading docks) or for areas with extremely large volumes (such as warehouses). Since neither of these types of spaces are present in Building 603, there is little reason to pursue the use of infrared heating.

P1 Conserve energy by lowering the domestic hot water supply temperature.

The hot water storage temperature of 60°C is required by Army regulations.

P2 Conserve energy by installing controls on the domestic hot water system to lower the heater's set-point temperature or to shut-off the heat source to the heater during non-peak hours.

The required controls are already present on the Building 603 domestic hot water system.

P3 Conserve energy by installing booster heaters at major hot water users and at high temperature hot water users.

The largest, single hot water consumer is the dishwasher, which is already equipped with an electric booster heater.

P4 Conserve energy by installing instantaneous hot water heaters in lieu of storage tank type heaters.

Given the relatively recent construction of Building 603, the replacement of the existing water heating equipment with instantaneous water heaters is highly impractical. In addition, heating domestic water with electricity is more expensive (in both cost and energy terms) than heating with district hot water -as is presently done.

P6 Conserve energy by installing additional insulation and/or repairing existing insulation on domestic hot water piping.

The insulation for the domestic hot water system requiring repair is located in the central mechanical space. This insulation has been evaluated as part of ECO

H17.

P9 Conserve energy by reclaiming waste heat from dishwasher wastewater.

The present dishwasher installation would make it extremely difficult to connect a water-to-water heat exchanger to the sanitary sewer connection on the dishwasher. Also, there is little space in the mechanical room for installing the additional pumps and secondary loop heat exchanger required to recover heat from the dishwasher wastewater.

P10 Conserve energy by installing solar collectors to pre-heat domestic hot water.

The total insolation (time and intensity of sunshine) in Vilseck makes solar heating technically impractical.

E2 Conserve lighting energy by eliminating excess fixtures. Where fixtures are close enough to each other, it may be possible to eliminate excess fixtures without creating dark spots.

The lighting fixtures in Building 603 are spaced in such a manner that no fixtures can be eliminated without causing undesirable variations in the lighting levels within individual spaces.

E3 Conserve energy by delamping selected fixtures.

See ECO E1. In some areas, selective de-lamping, rather than re-lamping with lower wattage lamps, may be the most cost effective method for reducing lighting levels to the required minimum.

E5 Conserve energy by replacing the incandescent lamps in exit lights with lower wattage fluorescent lamps.

This has already been done in Vilseck Building 603.

E6 Conserve energy by installing improved reflectors or lighting fixtures and reducing the fixtures lamp wattage.

The lighting fixtures in Vilseck Building 603 are relatively new fixtures which are already equipped with efficient reflectors and low wattage lamps.

E8 Conserve energy by replacing existing lamps with energy efficient U-tube fluorescent lamps.

For architectural reasons, the fixtures in Building 603 are not suitable for re-lamping with U-tube fluorescent lamps.

E9 Conserve energy by replacing existing incandescent bulbs with compact fluorescent bulbs.

See commentary on ECO E8.

E11 Conserve energy by turning exterior lighting "on" and "off" by means of photocells.

ECO E10 has been developed to minimize the energy used for exterior lighting. Photocells have been included in the development of ECO E10.

E12 Conserve energy by turning exterior lighting "on" and "off" by means of timers.

ECO E10 has been developed to turn the exterior lighting "on" and "off" by means of a photocell. Therefore, this ECO will not be pursued. See, also, ECO E11.

E13 Conserve energy by providing task level switching for interior lights. Task level switching will allow the lighting level to be varied to match the activity within the space.

Because the Dining Facility is not a multiple use facility (i.e., the spaces are all designed for a single, specific activity) task level switching is not appropriate for this building.

E15 Conserve energy by turning interior lighting "on" and "off" by means of timers.

ECO E14 has been developed to minimize energy usage within the Dining areas. Therefore, this ECO will not be pursued.

E16 Conserve energy by turning interior lighting "on" and "off" by means of space occupancy sensors.

ECO E14 has been developed to control interior lighting by means of a photocell. Therefore, this ECO will not be pursued. See, also, ECO E15.

E17 Conserve energy by replacing existing motors with energy efficient motors.

Given the relatively short period of time that the existing motors have been in service, it would be both expensive and wasteful to replace them with newer motors. In addition, the efficiency of newer motors is only marginally better

than that of motors built less than ten years ago.

E18 Conserve energy by replacing oversized/undersized motors with motors which have their peak efficiency at the actual system load.

On inspection, the large (greater than 1/2HP) motors at Vilseck Building 603 were found to be well matched to their service loads.

E19 Conserve energy by adding power factor correcting capacitors to existing motors.

The motors on equipment installed in Building 603 are well suited for their service and do not require power factor correction.

E20 Conserve energy by equipping motors which experience highly variable loads with variable frequency drives.

The only motors which are subjected to this type of loading are the hot water pumps. These pumps are already equipped with variable frequency drives.

2.2 The following ECO's were rejected after a rigorous investigation of their merits. Rejection was based on the ECO's having a Savings-to-Investment Ratio (SIR) of less than 1.0 or a payback of greater than 10 years.

TABLE D-2 ECO'S REJECTED - VILSECK BUILDING 603

ECO NO.	ENERGY SAVINGS (MBTU/YR)	FUEL **	COST SAVINGS (DM/YEAR)	COST (DM)	SIR	PAYBACK (YEARS)
P8	6.8	DHW	245	2,822	1.50	11.5
H10	1.4	DHW	50	2,436	0.36	48.2
E10	1.1	E	43.5	1,546	0.33	35.5
E7	79.4	E	3,257	237,328	0.16	72.9

* MBTU = 10^6BTU's
** Fuel types are: Electricity (E) and District Hot Water (DHW)

APPENDIX E

ANNUAL ENERGY CONSUMPTION DATA

Baker Engineers

Subject: Grafenwöhr / Vilseck Energy Audit — S.O. No. 23098-45-BRM

Annual Energy Consumption — Sheet No. 1 of 4

Drawing No.

Computed by CEN — Checked By — Date April 17, 1993

Grafenwöhr Building 101

Electricity Consumption

Date	Meter Reading	Month-to-Month Differential	Consumption (Differential × Factor)
April 30, 1992	18,376.3		
June 1, 1992	18,842.3	18,842.3 - 18,376.3 = 467.0	467.0 × 120 = 56,040 KWH
June 29, 1992	19,193.7	19,193.7 - 18,842.3 = 351.4	351.4 × 120 = 42,170 KWH
July 31, 1992	19,628.4	19,628.4 - 19,193.7 = 434.7	434.7 × 120 = 52,160 KWH
Aug 31, 1992	20,086.3	20,086.3 - 19,628.4 = 457.9	457.9 × 120 = 54,950 KWH
Sept 30, 1992	20,478.8	20,478.8 - 20,086.3 = 392.5	392.5 × 120 = 47,100 KWH
Oct 30, 1992	20,876.3	20,876.3 - 20,478.8 = 397.5	397.5 × 120 = 47,700 KWH
Nov 30, 1992	21,314.9	21,314.9 - 20,876.3 = 438.6	438.6 × 120 = 52,630 KWH
Dec 31, 1992	—		= 47,070 KWH
Jan 31, 1993	—		= 47,070 KWH
Feb 28, 1993	—	(22,883.8 - 21,314.9)/4 = 392.2	392.2 × 120 = 47,070 KWH
Mar 25, 1993	22,883.8		= 47,070 KWH
April 30, 1993		(467.0 + 392.2)/2 = 429.6	= 47,070 KWH 429.6 × 120 = 51,550 KWH
		Avg of May '92 & April '93	Annual Total = 592,580 KWH

Baker Engineers

S.O. No. 20098-45-32M

Subject: Grafenwöhr / Vilseck Energy Audit

Sheet No. 2 of 4

Annual Energy Consumption

Drawing No.

Computed by CEM Checked By Date April 16, [illegible]

Grafenwöhr Building 101

District Hot Water Consumption

Date	Meter Reading	Month-to-Month Differential	Consumption (Differential × 1000)
Apr. 30, 1992	1837.6		
June 1, 1992	1928.2	1928.2 - 1837.6 = 90.6	90.6 × 1000 = 90,600 KWH
June 29, 1992	1964.0	1964.0 - 1928.2 = 35.8	35.8 × 1000 = 35,800 KWH
July 31, 1992	2002.4	2002.4 - 1964.0 = 38.4	38.4 × 1000 = 38,400 KWH
Aug 31, 1992	2047.6	2047.6 - 2002.4 = 45.2	45.2 × 1000 = 45,200 KWH
Sept 30, 1992	2105.2	2105.2 - 2047.6 = 57.6	57.6 × 1000 = 57,600 KWH
Oct 30, 1992	2205.8	2205.8 - 2105.2 = 100.6	100.6 × 1000 = 100,600 KWH
Nov. 30, 1992	2321.9	2321.9 - 2205.8 = 116.1	116.1 × 1000 = 116,100 KWH
Dec 31, 1992	——		112.9 × 1000 = 112,900 KWH
Jan 31, 1993	——	(2773.2 - 2321.9)/4 = 112.8	112.8 × 1000 = 112,800 KWH
Feb 28, 1993	——		112.8 × 1000 = 112,800 KWH
Mar 25, 1993	2773.2		112.8 × 1000 = 112,800 KWH
Apr. 30 1993	——	(90.6 + 112.8)/2 = 101.7	101.7 × 1000 = 101,700 KWH
			Annual Total = 1,037,300 KWH

Electrical = 592,580

District Hot Water = 1,037,300

Total Energy Consump = 1,629,880 KWH

Baker Engineers

S.O. No. 20098-65-JZM

Subject: Grafenwöhr / Vilseck Energy Audit

Sheet No. 3 of 4

Annual Energy Consumption

Drawing No.

Computed by CZM Checked By

Date April 17, 1993

Vilseck Building 603

Electrical Consumption

Date	Meter Reading	Month-to-Month Change	Consumption (Differential × Factor)
May 4, 1992	16,086		
June 1, 1992	16,310	16310 - 16,086 = 224	224 × 250 = 56,000 KWH
June 30, 1992	16,560	16,560 - 16,310 = 250	250 × 250 = 62,500 KWH
July 31, 1992	——	(17,078 - 16,560)/2 = 259	259 × 250 = 64,750 KWH
Aug 31, 1992	17,078		259 × 250 = 64,750 KWH
Sep 30, 1992	17,298	17,298 - 17,078 = 220	220 × 250 = 55,000 KWH
Oct 31, 1992	——		264.2 × 250 = 66,050 KWH
Nov 30, 1992	——		264.2 × 250 = 66,050 KWH
Dec 31, 1992	——		264.2 × 250 = 66,050 KWH
Jan 31, 1993	——		264.2 × 250 = 66,050 KWH
Feb 28, 1993	——		264.2 × 250 = 66,050 KWH
Mar 31, 1993	18,883	(18,883 - 17,298)/6 = 264.2	264.2 × 250 = 66,050 KWH
April 30, 1993		(224 + 264.2)/2 = 244.1	244.1 × 250 = 61,020 KWH
			Annual Total = 760,320

Baker Engineers

S.O. No. 20098-45-3ZM

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

Sheet No. 4 of 4

ANNUAL ENERGY CONSUMPTION

Drawing No.

Computed by CEM Checked By Date APRIL 17, 1993

VILSECK BUILDING 603

DISTRICT HOT WATER CONSUMPTION

DATE	METER READING	MONTH-TO-MONTH CHANGE	CONSUMPTION (CHANGE x FACTOR)
MAY 4, 1992	7106.5		
JUNE 1, 1992	7763.0	7763.0 - 7106.5 = 656.5	656.5 x 1000 = 656,500 KWH
JUNE 30, 1992	8084.0	8084.0 - 7763.0 = 321.0	321.0 x 1000 = 321,000 KWH
JULY 31, 1992	8142.0	8142.0 - 8084.0 = 58.0	58.0 x 1000 = 58,000 KWH
AUG 31, 1992	8187.0	8187.0 - 8142.0 = 45.0	45.0 x 1000 = 45,000 KWH
SEPT 30, 1992	8337.0	8337.0 - 8187.0 = 150.0	150.0 x 1000 = 150,000 KWH
OCT 31, 1992	———	(8497.0 - 8337.0)/2 = 80.0	80.0 x 1000 = 80,000 KWH
NOV 30, 1992	8497.0		80.0 x 1000 = 80,000 KWH
DEC 31, 1992	———		112.33 x 1000 = 112,330 KWH
JAN 31, 1993	———		112.33 x 1000 = 112,330 KWH
FEB 28, 1993	———	(9171.0 - 8497.0)/4 = 112.33	112.33 x 1000 = 112,330 KWH
MAR 31, 1993	9171.0		112.33 x 1000 = 112,330 KWH
APRIL 30, 1993	———	(656.5 + 112.33)/2 = 384.4	384.4 x 1000 = 384,400 KWH
			ANNUAL TOTAL = 2,224,220 KWH

TOTAL ANNUAL ENERGY CONSUMPTION =

ELECTRICAL = 760,320 KWH

DISTRICT HOT WATER = 2,224,220 KWH

2,984,540 KWH

APPENDIX F

SUPPORTING DATA AND DOCUMENTATION FOR DEVELOPED PROJECTS

1.0 Units

The following pages contain the energy/cost savings calculations for all of the developed ECO's. Note that all energy savings are calculated in units of MBTU's. This is the standard unit in the Life-Cycle Cost Analysis Summary Sheet currently adopted for use by the U.S. Army. Note, however, that on that form, MBTU equals one million (1,000,000) BTUs (British Thermal Units), not one thousand (1,000) BTUs, which is the normal value associated with the abbreviation MBTU. The reader should be aware of this variation in the use of this abbreviation.

1.1 Energy Costs

The energy costs used in this report were based on the average annual energy costs incurred at Grafenwöhr and Vilseck during the calendar year 1991. Copies of the billing summary sheets received from the two bases are presented at the end of this discussion.

<u>Grafenwöhr</u>

Electricity Costs = DM 0.142/kWh

$$\frac{DM\ 0.142}{kWH} \times \frac{kWH}{3413BTU} \times \frac{1{,}000{,}000\ BTU}{MBTU} = DM\ 41.60/MBTU$$

District Hot Water Costs = DM 104.46/MWH

$$\frac{DM\ 104.46}{MWH} \times \frac{MWH}{1{,}000\ KWH} \times \frac{KWH}{3{,}413\ BTU} \times \frac{1{,}000{,}000\ BTU}{MBTU} = DM\ 30.61/MBTU$$

Vilseck

Electricity Costs = DM 0.140/kWh

$$\frac{DM\ 0.140}{kWH} \times \frac{kWH}{3413\ BTU} \times \frac{1{,}000{,}000\ BTU}{MBTU} = DM\ 41.02/MBTU$$

District Hot Water Costs = DM 123.10/MWH

$$\frac{DM\ 123.10}{MWH} \times \frac{MWH}{1{,}000\ KWH} \times \frac{KWH}{3{,}413\ BTU} \times \frac{1{,}000{,}000\ BTU}{MBTU} = DM\ 36.07/MBTU$$

1.2 Adjusted Internal Rate of Return (AIRR)

The last line on the Life Cycle Cost Analysis Summary Sheet (Line 7) is the Adjusted Internal Rate of Return (AIRR). This rate has been calculated in accordance with the formula presented in the "Energy Conservation Investment Program (ECIP) Guidance memorandum issued on 14 November 1992 by CEHS-FU-M. This formula is:

$$AIRR = [(1+d)\ (SIR^{1/N}) - 1]\ \ (100)$$

Where:

SIR	=	Savings to Investment Ratio (Line 6)
d	=	Discount rate (currently = 4%)
N	=	Economic Life (20 years for ECIP Projects)

Card NO.:	0001-1987	Delivery:	HIGH TENSION N	Supplier:	OBAG
Service-Location:	GRAFENWOEHR-EAST-CAMP	Contract-No:	DAJA04-88-D-0030	Permitted-PF:	0.0
Contract Demand:	5000 KW	Min Demand:	2800 KW	Max Demand:	6300 KW
Main-Trans-Cap:	SEE TRANS LIST	Metering Fee:	14.00 DM	Rent	
Dem Chrg:	ALL 232.80 DM	Next:		Next:	
Eng Chrg HT:	1ST MIO 11.7 PF/KWH	Next:	10 MIO 11.7 PF/KWH	Next:	ALL 11.4 PF/KWH
Eng Chrg NT:	1STO.6 MIO 9.4PF/KWH	Next:	6 MIO 9.4 PF/KWH	Next:	ALL 9.2 PF/KWH
Rct Chrg:	ALL 0.037 DM	Next:		Next:	

Remarks: MAIN STATION: DEMAND 10 ALL FURTHER 8000

MO	KW	ON-PEAK	OFF-PEAK	TOTAL KWH	UTIL	REACTIVE	PF	DEM.CH.	ACT.COST	PF-COST	FEES	TOT.COST	AVG
Ja	4596.90	1404340	1112310	2516650	547	404290	0.987	96000.00	256150.54	0.00	42.00	352192.54	0.140
Fe	4783.20	1351010	912305	2263315	473	398350	0.985	96000.00	228657.15	0.00	42.00	324699.15	0.143
Ma	3851.00	1201605	788625	1990230	517	265300	0.991	96000.00	201387.73	0.00	42.00	297429.73	0.140
Ap	4323.30	859815	1532435	2392250	553	386830	0.987	96000.00	228031.41	0.00	42.00	324373.41	0.136
My	3610.00	774755	1100035	1874790	519	303120	0.987	96000.00	181313.48	0.00	42.00	277355.48	0.148
Jn	3384.00	708690	1027580	1736270	513	194605	0.994	96000.00	167709.71	0.00	42.00	263751.71	0.152
Jl	3774.70	801590	1135640	1937230	513	272990	0.990	96000.00	187376.38	0.00	42.00	283418.38	0.146
Au	3813.80	812085	1106845	1918930	503	311600	0.987	96000.00	186030.91	0.00	42.00	282072.91	0.147
Se	3412.00	719205	897785	1616990	474	161290	0.995	96000.00	157579.45	0.00	42.00	253621.45	0.157
O	4399.80	1296875	996130	2293105	521	389285	0.986	96000.00	229970.05	0.00	42.00	326021.05	0.142
No	4581.80	1306585	977515	2284100	498	475885	0.979	96000.00	229421.45	0.00	42.00	325463.45	0.142
De	4113.40	1173175	984430	2157605	525	333550	0.988	96000.00	148580.45	0.00	42.00	244622.45	0.113
TO	4053.73	12409830	12571635	24981465	6163	3897095	0.988	1152000.00	2402517.71	0.00	504.00	3555021.71	0.142

1 9 9 2

Verbrauchskosten Heizung

SUPPLIER: Fränkische Gaslieferungsgesellschaft

CONTRACT #: DAJA04-87-D-0075 CONTRACT DEMAND: 30 MW PRESSURE/TEMPERATURE: 160° W/100° S

SERVICE LOCATION: Grafenwoehr East Camp

METER RENTAL CHARGES: According to Para 3.2. of contract APR MINIMUM: 60 % = 32,400 MWH LPR MINIMUM: 70 % = 294 MWH

REPAY OF INVESTMENT: 142,750.00 DM per month METER FEE: 760.00 DM per month USE PER DAY: 14 hrs

DEMAND CHARGE: 339,428 PF per KWH * ENERGY CHARGE: 45,524 DM per MWH *

* DM-Amounts within this positions are depending from the Annual Demand Charges and the Work Price of the "Price Adjustment Clause" Paragraph § 5 of the contract.

	ENERGY USE MWH	DEMAND CHARGE	ENERGY CHARGE	REPAY OF INVESTMENT	METER FEE	TOTAL COST	AVERAGE COST / MWH
JANUARY	6,578.30	83,159.86	182,024.00	142,750.00	760.00	408,693.86	62.13
FEBRUARY	6,807.80	83,159.86	182,024.00	142,750.00	760.00	408,693.86	60.04
MARCH	5,512.00	83,159.86	182,024.00	142,750.00	760.00	408,693.86	74.15
APRIL	5,294.41	83,159.86	190,268.00	142,750.00	760.00	416,937.86	78.76
MAY	4,610.37	83,159.86	190,268.00	142,750.00	760.00	416,937.86	90.44
JUNE	2,271.82	83,159.86	190,268.00	142,750.00	760.00	416,937.86	183.53
JULY	1,410.43	83,159.86	182,096.00	142,750.00	760.00	408,765.86	289.82
AUGUST	1,386.09	83,159.86	182,096.00	142,750.00	760.00	408,765.86	294.91
SEPTEMBER	1,174.52	83,159.86	182,096.00	142,750.00	760.00	408,765.86	348.03
OCTOBER	1,814.66	85,850.45	87,727.89	142,750.00	760.00	317,088.34	174.73
NOVEMBER	4,510.20	85,850.45	173,420.00	142,750.00	760.00	402,780.45	89.30
DECEMBER	4,826.80	85,850.45	173,420.00	142,750.00	760.00	402,780.45	83.44
TOTAL	46,197.40	1,005,990.09	2,097,731.89	1,713,000.00	9,120.00	4,825,841.98	104.46

Card NO.: 0070-1987
Service Location: VILSECK SOUTH CAMP
Contract Demand: 4560 KW 5500
Main Trans Cap: SEE TRANS LIST

Contract No: [illegible]
Min Demand: 1900 KW
Metering Fee: 56.0 DM/MO

Max Demand: 4500 KW
MFS: [illegible]
Nx.: [illegible]

Dem Chrg: ALL 230.00 DM
Next: [illegible]
Next: [illegible]

Eng Chrg HT: 1ST MIO 11.05 PF/KWH
Next: 10 MIO 11.05 PF/KWH
Next: ALL 11.05 PF/KWH

Eng Chrg NT: 1ST 0.6MIO 8.7 PF/KWH
Next: 6 MIO 8.7 PF/KWH
Next: ALL 8.7 PF/KWH

Rec Chrg: ALL 0.0370 DM

Remarks: METER CONST: DEMAND 1, ALL FURTHER 4000

MO	KW	ON-PEAK	OFF-PEAK	TOTAL KWH	UTIL	REACTIVE	PF	REC.Cd.	ACT.COST	PF COST	FEES	TOT.COST	AVG
Ja	5392.00	1659800	1363040	3022840	561	268800	0.996	96000.00	304191.36	0.00	56.00	402248.36	0.133
Fe	5152.00	1341560	1080480	2422040	509	258050	0.995	96000.00	264344.14	0.00	56.00	360400.14	0.137
Ma	5192.00	1670440	1087920	2758360	531	316080	0.993	96000.00	279232.66	0.00	56.00	375288.66	0.136
Ap	5248.00	1032760	1814560	2847320	543	321680	0.994	96000.00	273961.17	0.00	56.00	370017.17	0.130
My	4808.00	902160	1312400	2214560	461	277830	0.992	96000.00	213867.46	0.00	56.00	309923.48	0.140
Ju	4728.00	919400	1383080	2302480	467	191640	0.997	96000.00	221921.66	0.00	56.00	317977.66	0.138
Jl	4256.00	949440	1390760	2340200	550	157640	0.998	96000.00	225909.24	0.00	56.00	321965.24	0.138
Au	4724.00	892920	1233040	2125960	503	160000	0.997	96000.00	205942.14	0.00	56.00	301998.14	0.142
Se	4664.00	995160	1310800	2305960	494	258680	0.994	96000.02	224004.76	0.00	56.00	320060.78	0.139
Oc	5304.00	1639720	1246620	2886240	544	430480	0.989	105600.0	289636.30	0.00	56.00	395292.30	0.137
No	5576.00	1600000	1183600	2783600	500	445600	0.987	105600.C	279947.20	0.00	56.00	385603.20	0.138
De	5576.00	1772920	1534480	3307400	593	435440	0.991	105600.0	440023.24	0.00	56.00	545679.24	0.165
TO	5010.00	15576280	15942680	31518960	6291	3522160	0.991	1180800.00	3224982.39	0.00	672.00	4406454.39	0.140

SERVICE LOCATION: VILSECK SOUTH CAMP

METER RENTAL CHARGES: [illegible] of contract

REPAYMENT OF INVESTMENT: [illegible] per month

DEMAND CHARGE: [illegible]

[illegible] DEMAND [illegible] 10770 [illegible] = 352 [illegible]

METER FEE [illegible] per month

ENERGY CHARGE: [illegible]

MONTH	[illegible]	ANNUAL DEMAND CHARGE	[illegible]	[illegible]	[illegible] PRICE	TOTAL [illegible]	AVERAGE
JANUARY	10809.27	110879.81	257530.00	310576.58	1749.00	680735.39	62.98
FEBRUARY	11365.46	110879.91	257530.00	310576.58	1749.00	690735.39	59.90
MARCH	9458.00	110879.81	257530.00	310576.58	1749.00	680735.39	71.97
APRIL	6949.06	110879.81	267855.00	310576.56	1749.00	691040.39	77.22
MAY	6601.80	110879.81	267835.00	310576.58	1749.00	691040.39	104.67
JUNE	3721.30	110879.81	267835.00	310576.58	1749.00	691040.39	185.70
JULY	2085.99	110879.81	257620.00	310576.58	1749.00	680825.39	326.38
AUGUST	1942.78	110879.81	257620.00	310576.58	1749.00	680825.39	350.44
SEPTEMBER	1664.65	180802.02	1081373.90	310576.58	1749.00	1574501.50	945.85
OCTOBER	2879.37	120482.64	320807.50	310576.58	1749.00	753615.72	261.73
NOVEMBER	7593.48	120482.64	320807.50	310576.58	1749.00	753615.72	99.25
DECEMBER	8576.87	120482.64	320807.50	310576.58	1749.00	753615.72	87.87
TOTAL	75648.03	1429286.42	4135131.40	3726918.96	20988.00	9312326.78	123.10

ECO H17

GRAFENWÕHR

PIPE INSULATION

S.O. No. 20098-45-BPM

Subject GRAFENWÖHR / VILSECK ENERGY AUDIT

ECO H17 - PIPE INSULATION

Sheet No. 1 of 5

Drawing No.

Computed by CEM Checked By Date MARCH 19, 1993

Baker

- ASSUMPTIONS:

1. AVERAGE WATER TEMPERATURE = 57.5°C (BASED ON A HOT WATER RESET SCHEDULE OF 85°C SUPPLY TEMPERATURE AT -18°C OUTDOOR AIR TEMPERATURE AND 40°C SUPPLY TEMPERATURE AT 16°C OUTDOOR AIR TEMPERATURE; AND A WATER TEMPERATURE DROP OF 10°C ACROSS THE FINNED TUBE RADIATION {i.e. AVG. SUPPLY TEMPERATURE = (85°C + 40°C)/2 = 62.5°C; AVG. RETURN TEMPERATURE = [(85-10) + (40-10)]/2 = 52.5°C; ∴ AVG. WATER TEMPERATURE (62.5°C + 52.5°C)/2 = 57.5°C)

2. INDOOR AMBIENT TEMPERATURE = 22°F

3. INSULATION IS FIBERGLASS PIPE INSULATION W/ A JACKET OF WHITE KRAFT PAPER BONDED TO ALUMINUM FOIL AND REINFORCED WITH GLASS FIBERS

4. INSULATION THICKNESS IS AS FOLLOWS:

PIPE SIZES UP TO 32 mm - 13mm INSULATION
PIPE SIZES FROM 38mm TO 51mm - 25mm INSULATION
PIPE SIZES OVER 51mm - 38 mm INSULATION

PIPE SIZE (NOM)	INSULATION THICKNESS	BARE PIPE HEAT LOSS PER LINEAR FOOT	INSULATED PIPE HEAT LOSS/FOOT	ENERGY SAVINGS PER FOOT	ENERGY SAVINGS W/METER
15mm	13 mm	32.9 BTUH/FT	8.2 BTUH/FT	24.7 BTUH/FT	23.7 W/M
20mm	13 mm	40.2 BTUH/FT	8.2 BTUH/FT	32.0 BTUH/FT	30.8 W/M
25mm	13 mm	49.3 BTUH/FT	11.0 BTUH/FT	38.3 BTUH/FT	36.8 W/M
32mm	13 mm	61.2 BTUH/FT	14.6 BTUH/FT	46.6 BTUH/FT	44.8 W/M
40mm	25 mm	68.5 BTUH/FT	9.1 BTUH/FT	59.4 BTUH/FT	57.1 W/M
50mm	25 mm	84.0 BTUH/FT	11.0 BTUH/FT	73.0 BTUH/FT	70.2 W/M
65mm	38mm	100.4 BTUH/FT	8.2 BTUH/FT	92.2 BTUH/FT	88.6 W/M
80mm	38 mm	119.6 BTUH/FT	11.0 BTUH/FT	108.6 BTUH/FT	104.4 W/M
100mm	38mm	135.1 BTUH/FT	11.0 BTUH/FT	124.1 BTUH/FT	119.3 W/M

HEAT LOSS VALUES IN CHART ARE BASED ON TABLES PUBLISHED BY OWENS-CORNING FIBERGLASS (PUB. NO. 3-IN-6496-E, OCT. 1986). VALUES WERE ADJUSTED FOR 35.5°C (63.9°F) TEMPERATURE DIFFERENTIAL. SEE PAGES 2-4 OF CALCULATIONS.

S.O. No. 20098-65-93 [illegible]

Subject: [illegible] / [illegible] Energy [illegible]

[illegible] Pipe Insulation

Sheet No. 2 of 5

Drawing No.

Computed by CEM Checked By

Date March 22, 1993

Baker

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1/2 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	36		71		159		275		422		606		715		836		970		1119		1283	
0.5	9	91	16	98	34	115	57	134	85	155	120	179	141	192	164	207	190	221	218	237	250	254
1.0	6	85	12	90	24	99	40	109	60	121	85	135	99	142	115	151	133	159	153	169	176	179
1.5	5	83	9	86	20	92	32	98	48	106	68	115	80	120	93	126	107	132	123	138	141	145
2.0	4	82	8	84	17	89	29	94	43	99	60	106	71	110	82	114	95	119	109	124	125	129
2.5	4	81	7	83	15	86	25	89	37	93	52	98	61	101	71	104	82	108	95	111	109	115
3.0	3	81	7	82	14	85	23	88	35	91	49	95	58	98	67	100	77	103	89	106	102	110
3.5	3	81	6	82	13	84	22	87	33	90	47	93	55	95	64	98	73	100	84	103	97	106
4.0	3	81	6	82	13	83	21	86	32	88	45	92	52	93	61	95	70	97	81	100	92	102
4.5	3	80	6	81	12	83	20	85	30	87	43	90	50	92	58	93	67	95	77	97	89	100
5.0	3	80	5	81	12	83	20	84	29	86	41	89	48	90	56	92	65	94	75	96	86	98
5.5	3	80	5	81	11	82	19	84	28	86	40	88	47	89	55	91	63	92	73	94	83	96
6.0	3	80	5	81	11	82	18	83	28	85	39	87	45	88	53	90	61	91	70	93	80	94

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 3/4 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	44		87		195		337		518		745		880		1030		1196		1380		1584	
0.5	9	89	17	96	35	110	58	126	87	145	123	166	144	177	167	190	193	203	222	217	255	232
1.0	7	86	14	91	29	102	49	114	73	128	102	144	120	153	139	162	161	173	185	184	212	195
1.5	6	84	11	87	23	93	38	101	56	110	79	120	93	126	108	132	125	139	143	146	164	154
2.0	5	83	9	85	20	90	33	95	49	102	69	110	80	114	93	119	108	124	124	129	142	135
2.5	4	82	8	83	17	86	28	90	42	95	59	100	69	103	80	107	92	110	106	114	122	119
3.0	4	81	7	82	16	85	26	89	39	92	55	97	64	100	74	102	86	106	99	109	113	113
3.5	4	81	7	82	15	84	25	87	37	91	52	95	60	97	70	99	81	102	93	105	107	108
4.0	3	81	7	82	14	84	23	86	35	89	49	93	58	95	67	97	77	99	89	102	102	104
4.5	3	81	6	81	13	83	22	85	33	88	47	91	55	93	64	95	74	97	85	99	97	101
5.0	3	80	6	81	13	83	21	85	32	87	45	90	53	91	62	93	71	95	82	97	94	99
5.5	3	80	6	81	12	83	21	84	31	86	44	89	51	90	60	92	69	93	79	95	91	97
6.0	3	80	6	81	12	82	20	84	30	86	42	88	49	89	57	90	66	92	76	94	87	95

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	54		106		239		413		637		919		1085		1271		1477		1706		1959	
0.5	12	92	22	100	47	119	78	139	116	162	164	188	192	202	224	217	259	234	294	251	342	269
1.0	8	86	15	90	31	99	51	110	75	123	106	137	124	145	145	153	167	163	192	172	220	183
1.5	6	84	12	87	25	93	41	100	61	109	86	119	101	125	117	131	136	138	156	145	179	152
2.0	5	82	10	85	21	89	35	95	53	101	74	109	87	113	101	118	117	123	134	128	154	134
2.5	5	82	9	84	19	87	32	92	47	97	67	103	78	106	91	110	105	114	121	118	138	123
3.0	4	81	8	83	18	86	29	90	44	94	62	99	72	102	84	105	97	108	111	112	128	116
3.5	4	81	8	82	17	85	27	88	41	92	58	96	68	99	79	101	91	104	104	107	120	111
4.0	4	81	7	82	16	84	26	87	39	90	55	94	64	96	74	98	86	101	99	104	113	107
4.5	4	81	7	82	15	84	25	86	37	89	52	92	61	94	71	96	82	98	94	101	107	103
5.0	3	81	7	81	14	83	24	85	35	88	50	91	58	92	68	94	78	96	90	99	103	101
5.5	3	80	6	81	14	83	23	85	34	87	48	90	56	91	65	93	76	95	87	97	100	99
6.0	3	80	6	81	13	82	22	84	33	86	46	89	54	90	63	91	73	93	84	95	96	97

S.O. No. 20098-05-BZA1

Subject: Guttenwood / Vickee Energy Audit

ECO #17 - Pipe Insulation

Sheet No. 3 of 5

Drawing No.

Computed by CEM Checked By

Date March 22, 1993

Baker

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1 1/4 IRON PIPE SIZE

HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH

80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE

0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	67		131		295		511		789		1141		1349		1581		1839		2126		2443	
0.5	18	97	34	109	72	135	119	164	179	195	253	231	297	250	345	270	400	291	461	313	529	337
1.0	10	87	19	93	39	104	65	118	97	133	137	150	161	160	187	170	216	181	248	193	285	206
1.5	7	84	13	87	28	93	46	101	68	109	96	120	113	125	131	131	151	138	174	145	199	153
2.0	6	83	12	86	25	91	42	98	63	105	88	114	103	119	120	124	139	130	160	136	183	143
2.5	6	82	11	84	22	88	37	93	55	99	78	106	91	110	106	114	122	119	141	124	161	129
3.0	5	82	10	83	20	87	34	91	50	96	71	101	83	105	97	108	111	112	128	116	147	121
3.5	5	81	9	83	19	86	31	89	47	93	66	98	77	101	90	104	103	107	119	111	136	115
4.0	4	81	8	82	18	85	29	88	44	91	62	96	72	98	84	101	97	103	112	107	128	110
4.5	4	81	8	82	17	84	28	87	41	90	58	93	68	96	79	98	92	100	105	103	121	106
5.0	4	81	8	82	16	84	27	86	40	89	56	92	65	94	76	96	88	98	101	100	115	103
5.5	4	81	7	81	15	83	25	85	38	88	54	91	63	92	73	94	84	96	97	98	111	101
6.0	4	80	7	81	15	83	24	85	36	87	51	89	60	91	70	93	81	94	93	96	106	98

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1 1/2 IRON PIPE SIZE

HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH

80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE

0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	75		148		334		579		894		1294		1530		1795		2089		2415		2777	
0.5	17	93	31	103	66	124	109	147	162	173	229	202	269	218	313	235	362	253	417	272	478	292
1.0	10	86	19	91	40	102	66	114	98	128	139	144	162	153	189	163	218	173	251	184	287	195
1.5	8	84	15	87	32	95	52	103	78	113	109	124	128	130	149	137	172	145	197	152	226	161
2.0	6	82	12	85	25	89	41	95	61	101	86	109	101	113	117	117	135	122	155	128	178	134
2.5	6	82	11	84	22	87	37	92	55	97	78	103	91	107	106	111	122	115	140	119	161	124
3.0	5	81	10	83	21	86	34	90	51	94	72	100	84	103	97	106	113	109	129	113	148	117
3.5	5	81	9	82	19	85	32	88	48	92	67	97	78	99	91	102	105	105	121	108	139	112
4.0	4	81	9	82	18	84	30	87	45	90	63	94	74	97	85	99	99	102	114	105	130	108
4.5	4	81	8	82	17	84	29	86	43	89	60	93	70	95	81	97	94	99	108	102	124	105
5.0	4	81	8	81	16	83	27	86	41	88	57	91	67	93	78	95	90	97	104	100	119	102
5.5	4	80	7	81	16	83	26	85	39	87	55	90	64	92	74	93	86	95	99	97	113	100
6.0	4	80	7	81	16	83	26	85	39	87	55	90	64	92	74	93	86	95	99	97	113	100

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 2 IRON PIPE SIZE

HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH

80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE

0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	92		181		409		710		1099		1593		1886		2214		2578		2984		3433	
0.5	18	92	34	101	71	121	118	142	176	166	249	193	291	208	339	224	392	241	451	258	517	277
1.0	12	87	22	92	46	103	77	115	114	130	161	146	188	156	219	165	253	176	291	187	334	199
1.5	9	84	17	88	36	95	59	104	88	114	124	125	145	132	169	139	195	146	224	154	257	163
2.0	8	83	14	86	30	91	50	98	74	105	104	114	122	119	142	124	164	130	188	136	216	143
2.5	7	82	13	84	27	89	44	94	66	100	92	107	108	111	126	116	145	120	167	125	191	131
3.0	6	82	12	83	24	87	40	91	60	97	84	103	98	106	114	110	132	114	151	118	173	123
3.5	6	81	11	83	22	86	37	90	55	94	78	99	91	102	105	105	122	109	140	112	160	116
4.0	5	81	10	82	21	85	34	88	51	92	72	96	84	99	98	102	113	105	130	108	149	111
4.5	5	81	9	82	20	84	32	87	48	90	68	94	80	97	93	99	107	102	123	105	141	108
5.0	5	81	9	82	19	84	31	86	46	89	65	93	76	95	88	97	102	99	117	102	134	105
5.5	4	81	8	81	18	83	29	85	44	88	62	91	72	93	84	95	97	97	111	99	127	102
6.0	4	80	8	81	17	83	28	85	42	87	59	90	69	92	81	94	93	95	107	98	123	100

S.O. No. 20058.45.32M

Subject: Greenwood / Vistica Energy Loss

500 h.? Pipe Insulation

Sheet No. 4 of 5

Drawing No.

Computed by CEM Checked By

Date March 22, 1993

Baker

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 2 1/2 IRON PIPE SIZE

HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH

80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE

0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

THICK	150.F HEAT LOSS	150.F SURF TEMP	200.F HEAT LOSS	200.F SURF TEMP	300.F HEAT LOSS	300.F SURF TEMP	400.F HEAT LOSS	400.F SURF TEMP	500.F HEAT LOSS	500.F SURF TEMP	600.F HEAT LOSS	600.F SURF TEMP	650.F HEAT LOSS	650.F SURF TEMP	700.F HEAT LOSS	700.F SURF TEMP	750.F HEAT LOSS	750.F SURF TEMP	800.F HEAT LOSS	800.F SURF TEMP	850.F HEAT LOSS	850.F SURF TEMP
BARE	110		215		487		846		1312		1904		2256		2650		3089		3576		4117	
0.5	21	93	40	102	83	122	138	144	206	169	290	196	340	212	396	228	458	245	528	263	605	282
1.0	14	87	26	92	54	104	88	117	132	132	185	149	217	158	252	169	292	179	335	191	384	204
1.5	9	84	18	87	37	93	61	101	90	110	127	120	149	126	173	132	200	139	230	146	263	154
2.0	8	83	15	85	32	90	52	96	78	103	110	112	129	116	149	121	173	127	198	133	227	139
2.5	7	82	14	84	28	88	47	93	70	99	98	106	115	110	133	114	154	118	177	123	203	129
3.0	7	82	12	83	26	87	43	91	64	96	90	102	105	105	122	109	141	113	162	117	185	121
3.5	6	81	11	83	24	86	39	89	59	93	82	98	96	101	112	104	129	108	149	111	170	115
4.0	6	81	11	82	22	85	37	88	55	92	77	96	91	99	105	101	121	104	140	107	160	111
4.5	5	81	10	82	21	84	35	87	52	90	73	94	86	96	100	99	115	102	132	104	151	108
5.0	5	81	9	82	20	84	33	86	49	89	69	92	81	94	94	97	108	99	125	101	143	104
5.5	5	81	9	82	20	84	33	86	49	89	69	92	81	94	94	97	108	99	125	101	143	104
6.0	5	81	9	81	19	83	32	86	47	88	66	91	77	93	90	95	104	97	120	99	137	102

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 3 IRON PIPE SIZE

HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH

80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE

0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

THICK	150.F HEAT LOSS	150.F SURF TEMP	200.F HEAT LOSS	200.F SURF TEMP	300.F HEAT LOSS	300.F SURF TEMP	400.F HEAT LOSS	400.F SURF TEMP	500.F HEAT LOSS	500.F SURF TEMP	600.F HEAT LOSS	600.F SURF TEMP	650.F HEAT LOSS	650.F SURF TEMP	700.F HEAT LOSS	700.F SURF TEMP	750.F HEAT LOSS	750.F SURF TEMP	800.F HEAT LOSS	800.F SURF TEMP	850.F HEAT LOSS	850.F SURF TEMP
BARE	131		258		583		1015		1575		2290		2715		3190		3721		4311		4966	
0.5	28	94	51	105	107	127	177	152	264	179	374	210	438	227	510	245	590	263	679	283	779	304
1.0	17	87	30	93	64	105	105	119	156	135	220	153	258	163	300	174	346	185	399	198	457	211
1.5	12	85	23	89	48	97	79	106	117	117	165	130	193	137	224	145	259	153	297	162	341	172
2.0	10	83	19	86	40	93	65	100	97	108	137	118	160	124	186	130	215	136	247	143	283	151
2.5	9	83	16	85	34	90	57	96	85	103	119	111	139	115	162	120	187	125	215	131	246	137
3.0	8	82	15	84	31	88	51	93	76	99	107	105	125	109	145	113	168	118	193	123	221	128
3.5	7	82	13	83	28	87	46	91	69	96	97	101	113	104	131	108	152	112	174	116	200	120
4.0	7	81	12	83	26	86	43	89	64	93	90	98	105	101	122	104	141	108	162	111	185	115
4.5	6	81	12	82	24	85	40	88	60	92	84	96	99	99	115	101	132	104	152	108	174	111
5.0	6	81	11	82	23	84	38	87	56	90	79	94	92	96	107	99	124	101	142	104	163	107
5.5	5	81	10	82	22	84	36	86	53	89	75	93	88	95	102	97	118	99	136	102	155	105
6.0	5	81	10	81	21	83	34	86	51	88	72	92	84	93	98	95	113	97	130	100	149	102

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 3 1/2 IRON PIPE SIZE

HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH

80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE

0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

THICK	150.F HEAT LOSS	150.F SURF TEMP	200.F HEAT LOSS	200.F SURF TEMP	300.F HEAT LOSS	300.F SURF TEMP	400.F HEAT LOSS	400.F SURF TEMP	500.F HEAT LOSS	500.F SURF TEMP	600.F HEAT LOSS	600.F SURF TEMP	650.F HEAT LOSS	650.F SURF TEMP	700.F HEAT LOSS	700.F SURF TEMP	750.F HEAT LOSS	750.F SURF TEMP	800.F HEAT LOSS	800.F SURF TEMP	850.F HEAT LOSS	850.F SURF TEMP
BARE	148		291		658		1148		1783		2595		3078		3619		4223		4895		5641	
0.5	31	95	57	105	120	128	198	153	297	181	419	212	492	229	572	247	662	266	763	286	875	307
1.0	15	86	29	91	59	101	98	112	146	125	206	141	241	149	280	158	323	168	372	178	426	189
1.5	12	84	23	88	47	95	78	103	116	113	164	125	192	131	223	138	257	146	296	154	339	162
2.0	10	83	19	86	40	92	66	98	99	106	139	115	163	120	189	126	218	132	251	138	287	145
2.5	9	82	17	85	36	89	59	95	87	101	123	109	143	113	167	118	192	123	221	128	253	134
3.0	8	82	15	84	32	88	52	92	78	97	109	104	128	107	149	111	172	115	197	120	226	125
3.5	7	82	14	83	29	86	48	90	72	95	101	100	118	104	137	107	158	111	182	115	208	119
4.0	7	81	13	83	27	86	45	89	67	93	94	98	110	101	128	104	147	107	169	110	194	114
4.5	6	81	12	82	25	85	42	88	62	91	87	95	102	98	118	100	137	103	157	106	180	110
5.0	6	81	12	82	25	85	42	88	62	91	87	95	102	98	118	100	137	103	157	106	180	110
5.5	6	81	11	82	24	84	39	87	59	90	83	94	97	96	112	98	130	101	149	104	171	107
6.0	6	81	11	82	23	84	38	86	56	89	79	93	92	95	107	97	124	99	142	102	163	104

S.O. No. 20018-42-32M

Subject: Grafenwöhr / Vilseck Energy Audit

ECO #17 - Pipe Insulation — Sheet No. [illegible] of ____

Drawing No. ____

Computed by CEM — Checked By ____ — Date March 22 [illegible]

- ESTIMATED INSULATION REPLACEMENT REQUIREMENTS:

4 m OF PIPE (DN 15 - DN 100) INSULATION	=	4 m
16 FITTINGS @ 0.25 m EA		4 m
		8 m

- AVG HEAT LOSS (DN 15 - DN 100) FOR PIPING

$(23.[illegible] + 30.8 + 36.8 + 44.8 + 51 + 70.2 + 88.6 + 104.4 + 119.[illegible])/9 = 64.0 \text{ W/M}$

- ENERGY SAVINGS = $5 \text{ MONTHS} \times \frac{1 \text{ YEAR}}{12 \text{ MONTHS}} \times \frac{8760 \text{ HOURS}}{\text{YEAR}} \times 8 \text{ METERS} \times \frac{64.0 \text{ W}}{\text{METER}} \times \frac{\text{KW}}{1000 \text{ W}} =$

$= 1,869 \text{ KWH/YR} = 6,378,214 \text{ BTU} = 6.38 \text{ MBTU}$

- INSULATION COST = 4 m × DM 80.00/M = DM 320.00

16 FITTINGS × DM 160.00/FITTING = DM 2560.00

DM 2880.00

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO H17

PROJECT TITLE: Pipe Insulation Replacement FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 23 Mar 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 2,880		
B.	SIOH	DM 173		
C.	DESIGN COST	DM 173		
D.	TOTAL COST (1A+1B+1C)	DM 3,226		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 3,226

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 30.61	6.4	DM 195.9	17.21***	DM 3,372
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		6.4	DM 195.9		DM 3,372

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 16.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 3,372

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.04

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.23 %

ECO P5

GRAFENWÖHR

STORAGE TANK INSULATION

S.O. No. 20058-42-3EN

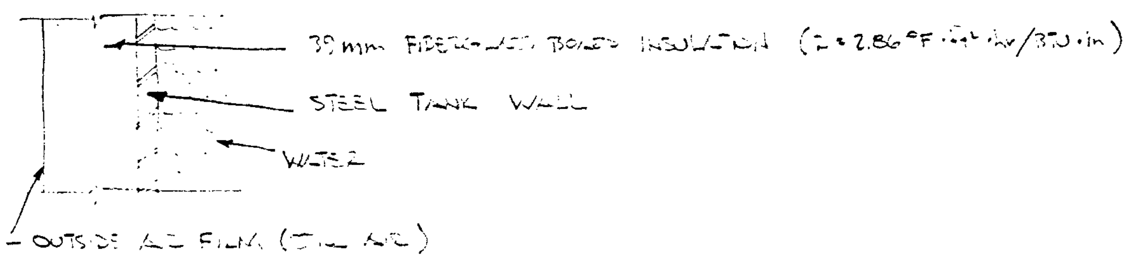
Subject: GRAFENWOHR / VILSECK ENERGY AUDIT - ECO 3A STORAGE TANK INSULATION

Sheet No. 1 of

Drawing No.

Computed by CEM Checked By Date MARCH 22, 1993

- TANK WATER TEMPERATURE = 60°C (140°F)
- MECHANICAL ROOM TEMPERATURE = 22°C (72°F)



OUTSIDE AIR FILM (STILL AIR)	$R = 1.46$
INSULATION	$R = 4.39$
STEEL	$R = 0.00$
	$R_T = 5.85$

$$U = 1/R_T = 0.171 \ \text{BTU}/°F \cdot ft^2 \cdot hr = 0.971 \ W/°C \cdot m^2$$

- ESTIMATED AMOUNT OF INSULATION TO BE REPLACED = 5 m²
- ENERGY SAVINGS $= 5 m^2 \times \dfrac{0.971 W}{°C \cdot m^2} \times (60°C - 22°C) = 184.5 W$
- ASSUMING THAT THE STORAGE WATER IS MAINTAINED AT 60°C THROUGHOUT THE ENTIRE YEAR - SINCE DOMESTIC WATER TEMPERATURE REQUIREMENTS ARE CONSTANT

$$\frac{365 \text{ DAYS}}{YR} \times \frac{24 \text{ HRS}}{DAY} \times 184.5 W \times \frac{kW}{1000 W} = 1616.2 \ kW/YEAR$$

- COST $= 5 m^2 \times \dfrac{DM\ 98.00}{m^2} = DM\ 490.00$

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO P5

PROJECT TITLE: Storage Tank Insulation FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 19 Apr 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 490.0		
B.	SIOH	DM 29.4		
C.	DESIGN COST	DM 29.4		
D.	TOTAL COST (1A+1B+1C)	DM 548.8		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 548.8

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 30.61	5.5	DM 169.0	17.21***	DM 2907.9
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		5.5	DM 169.0		DM 2907.9

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 1,000,000 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM		0	DM 0
b.		DM		0	DM 0
c.		DM		0	DM 0
d.	TOTAL	DM		0	DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 3.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 2908

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 5.30

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.04 %

ECO P7

GRAFENWÖHR

FLOW RESTRICTORS

S.O. No. 22098-45-022N

Subject: Grafenwöhr/Vilseck Energy Audit

ECO 27 - Flow Restriction

Sheet No. 1 of

Drawing No.

Computed by CEM Checked By

Date April 19, 1993

- Assumptions:

1. Average water temperature = 60°C (140°F)

2. Flow restricting aerators (which are easily screwed into faucet outlets) reduce lavatory faucet flow from 3 GPM to 0.5GPM

3. Approximately 1000 - 1200 meals are served each day, assume that 1/3 of the diners washes his/her hands for a 20 seconds (average) duration

   1200 diners × 1/3 × 20 seconds × 1 minute/60 seconds = 133 minutes

   And, the kitchen/cleaning/baking staff of approximately 60 (20/meal) must wash their hands for a average duration of 1 minute each

   60 staff × 1 minute each = 60 minutes

   Total lavatory usage = 133 minutes
   + 60 minutes
   193 minutes, say 200 minutes/day

   200 minutes/day × 350 days/year = 70,000 minutes annually

   If lavatory water use is reduced from 3 GPM to 0.5 GPM, the savings is 2.5 GPM.

   Total annual water savings = 2.5 GPM × 70,000 minutes
   = 175,000 GAL

4. Assuming that 2/3 of the water used for hand washing is hot water,

   2/3 × 175,000 gallons = 116,700 gallons of water will not have to be heated from 10°C (50°F) to 60°C (140°F)

   $116{,}700\ GAL \times \frac{8.3\#}{GAL} \times \frac{1\ BTU}{1\# \cdot °F} \times (140 - 50°F) = 87{,}174{,}900\ BTU = 87.2\ MMBTU$

5. Aerator nozzles cost ≈ DM 4.80

   Total cost = 6 lavatories × DM 4.80 EA = DM 28.80

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO P7

PROJECT TITLE: Flow Restrictors FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 21 Apr 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 28.80		
B.	SIOH	DM 1.80		
C.	DESIGN COST	DM 1.80		
D.	TOTAL COST (1A+1B+1C)	DM 32.40		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 32.40

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 30.61	87.2	DM 2669.2	17.21***	DM 45,936.8
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		87.2	DM 2669		DM 45,937

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. <u>TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4):</u> DM 0

4. <u>SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)):</u> 0.01 YEARS

5. <u>TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C):</u> DM 45,937

6. <u>SAVINGS TO INVESTMENT RATIO (SIR) 5/1G:</u> 1417.8

7. <u>ADJUSTED INTERNAL RATE OF RETURN (AIRR):</u> 49.5 %

ECO P8

GRAFENÖHR

AUTOMATIC SHUT-OFF FAUCETS

Baker Engineers

S.O. No. 20098-45-32M

Subject: Grafenwöhr / Vilseck Energy Audit

ECO P8 — Sheet No. 1 of

Automatic Shut-off Faucets — Drawing No.

Computed by CEM — Checked By — Date 29 / April 1995

Assumptions:

1. Average water temperature = 60°C (140°F)
2. Automatic shut-off faucets will shut-off flow after 4 seconds (most are adjustable from 2 - 15 seconds)
3. Average hand washing will require 3 pushes of flow level for a total of 12 seconds flow duration vs. 20 seconds duration estimated under ECO P7. So the 70,000 minutes per year (of lavatory use) estimated in ECO P7 will be reduced by

$$\frac{20\,sec. - 12\,sec}{20\,sec} \times 70{,}000\,MIN = 28{,}000\,MINUTES$$

4. Assuming that the flow restrictors discussed in ECO P7 have been installed, the annual water savings will be

$$28{,}000\,MINUTES \times \frac{0.5\,GAL}{MINUTE} = 14{,}000\,GALLONS$$

5. Assuming that both the hot & cold water are used for handwashing, 50% of the water used will be hot

Hot water = 0.50 × 14,000 GAL = 7,000 Gallons, annually

6. Following ECO P7, the annual energy savings will be

$$\frac{7{,}000\,GAL}{YR} \times \frac{8.3^{\#}}{GAL} \times \frac{1\,BTU}{1^{\#}\cdot{}^{\circ}F} \times 90^{\circ}F = 5{,}229{,}000\,BTU\ PER\ YEAR$$

Estimated Cost = 6 lavatories × DM 180/LAV = DM 1080

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO P8

PROJECT TITLE: Automatic Shut-off Faucets FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 29 Apr 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1.	INVESTMENT COSTS:			
A.	CONSTRUCTION COST	DM 1,080		
B.	SIOH	DM 65		
C.	DESIGN COST	DM 65		
D.	TOTAL COST (1A+1B+1C)	DM 1,210		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 1,210

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 30.61	5.2	DM 159.2	17.21***	DM 2739.4
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		5.2	DM 159.2		DM 2739.4

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 7.6 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 2739.4

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.26

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 8.34 %

ECO E1

GRAFENWÖHR

LIGHTING LEVEL REDUCTION

S.O. No. 20098 · 25 · BRM

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

ECO E1

REDUCE LIGHTING LEVELS

Computed by CEM Checked By

Sheet No. 1 of

Drawing No.

Date 29 APRIL 1993

Baker

GRAFENWÖHR

FROM GERMAN CALCULATIONS:

A REDUCTION IN ILLUMINATION INTENSITY (-15%) IN THE KITCHEN AND IN THE ADJACENT ROOMS IS POSSIBLE BY DE-LAMPING

SPACE	PRESENT LIGHTING LEVEL	PROPOSED LIGHTING LEVEL
KITCHEN	450-700 LUX	380-600 LUX
ADJACENT SPACES	150-200 LUX	125-170 LUX

SPACE	PRESENT INSTALLED WATTAGE LAMPS x WATTS/LAMP = WATTAGE	PROPOSED INSTALLED WATTAGE
KITCHEN	90 x 36W = 3240W	76 x 36W = 2736W
ADJACENT SPACES	38 x 36W = 1368W	32 x 36W = 1152W
BALLASTS	128 x 13W = 1664W	108 x 13W = 1404W
TOTAL WATTAGE	6272W	5292W

- TOTAL HOURLY SAVINGS = 6272W - 5292W = 980W

- BASED ON 7410* HOURS OF OPERATION, THE TOTAL ANNUAL ENERGY SAVINGS IS (7410 HRS x 980W) / 1000 W/KW

7261.8KWH

$$7261.8\,KWH \times \frac{3413\,BTU}{KWH} \times \frac{1\,MMBTU}{10^6\,BTU} = 24.78\,MMBTU$$

- COST OF DE-LAMPING = COST OF DISCONNECTING THE POWER TO 10 TWO-LAMP FIXTURES.

10 FIXTURES x DM 72,18 = DM 722

BASED ON MEANS COST FOR INSTALLATION OF SAME FIXTURE

S.O. No. 20058-25-32M

Subject: Grafenwöhr / Vilseck Energy Audit

Grafenwöhr ECO E1 — Sheet No. 2 of

Reduce Lighting Levels — Drawing No.

Computed by CEM — Checked By — Date 20 April 1983

* Hours of Operation (Kitchen Spaces)

M,T,W,F	0330 - 2400 = 20.5 HRS	2 HR BEFORE BREAKFAST TO END OF BAKING SHIFT
TH	0330 - 2400 = 20.5 HRS	
S,S	0400 - 2400 = 20.0 HRS	

ANNUAL TOTAL = 52 WKS × [(5 × 20.5) + (2 × 20)]

= 7410 HRS

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO E1

PROJECT TITLE: Reduce Lighting Levels FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 29 Apr 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 722		
B.	SIOH	DM 43		
C.	DESIGN COST	DM 43		
D.	TOTAL COST (1A+1B+1C)	DM 808		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 808

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.6	24.78	DM 1,030.8	11.59**	DM 11,947.5
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		24.8	DM 1031		DM 11,948

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 1.28 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 11,948

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 14.79

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 18.99 %

ECO E7

GRAFENWÖHR

LIGHTING FIXTURE CONVERSION

Baker Engineers

S.O. No. 20093-47-B2M

Subject: Grafenwöhr / Vilseck Energy Audit

ECO E7 Sheet No. 1 of

Lighting Fixture Conversion Drawing No.

Computed by CEM Checked By Date 20 April 1993

FROM GEHRMANN CONSULT FAX OF 2 MARCH, 1993:

WITHOUT REDUCING THE LIGHTING LEVEL WITHIN BUILDING 101, THE NUMBER OF 36W LAMPS IN THE LIGHTING SYSTEM CAN BE REDUCED FROM 380 LAMPS TO 334 LAMPS BY REPLACING THE EXISTING FLUORESCENT LAMP BALLASTS WITH ELECTRONIC BALLASTS.

- WITH CONVENTIONAL BALLASTS, THE CONNECTED LOAD IS:

  380 LAMPS × 0.049 KW/LAMP = 18.62 KW

- WITH ELECTRONIC BALLASTS, THE CONNECTED LOAD WILL BE:

  334 LAMPS × 0.036 KW/LAMP = 12.02 KW

SO THE SAVINGS WILL BE 18.62 - 12.02 = 6.6 KW

- BASED ON 3500* HRS OF OPERATION, ANNUALLY, THE SAVINGS WILL BE:

  3500 HRS × 6.6 KW = 23,100 KWH

OR $23{,}100\ \text{KWH} \times \frac{3413\ \text{BTU}}{\text{KWH}} \times \frac{\text{MMBTU}}{10^6\ \text{BTU}} = 78.84\ \text{MMBTU}$

- ESTIMATED COST OF INSTALLING ELECTRONIC BALLASTS IS:

  334 LAMPS × 650 DM/LAMP = 217,100 DM

* SEE CALC, ECO E14 FOR CALCULATION OF OPERATING HOURS

52 WKS/YR × 67.25 HRS/WK = 3497 HRS, SAY 3500 HRS

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO E7

PROJECT TITLE: Lighting Fixture Conversion FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 29 Apr 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 217,100		
B.	SIOH	DM 13,026		
C.	DESIGN COST	DM 13,026		
D.	TOTAL COST (1A+1B+1C)	DM 243,152		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 243,152

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.60	78.84	DM 3279.7	11.59**	DM 38,012
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		78.8	DM 3280		DM 38,012

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	2 YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 74.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 38,012

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.16

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): - 5.22 %

ECO E10

GRAFENWÖHR

DIMMING HARDWARE FOR

LIGHTING FIXTURES

Baker

S.O. No. 20098-25-32M.

Subject: GRUFENWÖHR / VILSECK ENERGY AUDIT

ECO E10 — Sheet No. 1 of 2

DIMMER/TIMER CONTROLS - EXTERIOR LIGHTS — Drawing No.

Computed by ______ Checked By ______ Date ______

GRUFENWÖHR

- FROM GERMAN CALCULATIONS: "EXTERIOR LIGHTING WILL BE CONTROLLED BY INSTALLATION OF DAWN/DUSK CONTROLLERS (PHOTOCELLS) AND TIMER-CONTROLLERS." THEREFORE, THIS ECO IS ACTUALLY A COMBINATION OF ECO'S E10, E11 AND E12. THE SUGGESTED CONTROL SCHEME IS TAKEN FROM USACERL TECHNICAL REPORT - E-90/07, DATED MAY 1990. QUOTING FROM PAGE 20: "ONE DIMMING SCENARIO FOR ARMY INSTALLATIONS IS TO HAVE EXTERIOR LIGHTING AT FULL POWER FROM DUSK UNTIL 2300 AND AT 55 PERCENT POWER (45 PERCENT LIGHT OUTPUT) THEREAFTER."

- EXISTING LIGHTING - EXTERIOR BUILDING LIGHTING - 980 W
  EXTERIOR AREA LIGHTING = 2175 W

- EXTERIOR BUILDING LIGHTING IS MANUALLY CONTROLLED. THE LIGHTING WAS TURNED "ON" DURING THE DAYLIGHT HOURS WHEN THE SURVEY TEAM WAS CONDUCTING THE ENERGY AUDIT. IT IS ASSUMED THAT THIS IS NOT THE NORM FOR THE FACILITY. HOWEVER, A DAWN/DUSK CONTROLLER CONNECTED TO A TIMER COULD PREVENT THIS ENTIRELY. THE DAWN/DUSK CONTROLLER COULD LIMIT THE OPERATION OF THESE EXTERIOR LIGHTS TO HOURS OF DARKNESS AND THE TIMER WOULD LIMIT THE LIGHTS TO 15-30 MINUTES OF OPERATION. IT IS ESTIMATED THAT THIS WOULD PROVIDE A REDUCTION IN USE OF THE LIGHTS OF APPROXIMATELY 2 HOURS PER DAY.

$$\text{TOTAL ENERGY SAVINGS} = \frac{365 \text{ DAYS} \times 2 \text{ HRS/DAY} \times 980 \text{ W}}{1000 \text{ W/KW}} = 715.4 \text{ KWH}$$

S.O. No. 20098-25-BRM

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

ECO E10

DIMMER/TIMER CONTROLS - EXTERIOR LIGHTS

Sheet No. 2 of 2

Drawing No.

Computed by ______ Checked By ______ Date ______

Baker

- EXTERIOR AREA LIGHTING CAN BE REDUCED BY 45% FROM 2300 HOURS TO DAWN. THIS WILL REDUCE POWER CONSUMPTION FOR, ON AVERAGE 5½ HOURS PER NIGHT.

$$\text{TOTAL ENERGY SAVINGS} = \frac{365\text{ DAYS} \times 5.5\text{ HRS/DAY} \times (45\% \times 2175\text{ W})}{1000\text{ W/KW}}$$

$$= 1964.8\text{ KWH}$$

- SO THE ANNUAL ENERGY SAVINGS FOR THIS ECO WILL BE:

BUILDING LIGHTING	- 715.4 KWH
AREA LIGHTING	- 1964.8 KWH
	2680.2 KWH

- ESTIMATED CONSTRUCTION COST:

DAWN/DUSK CONTROLLER	=	DM 246.00
TIMER-CONTROLLERS (2@DM 272.00 EA)	=	DM 544.00
DIMMER	=	DM 40.00
INSTALLATION	=	DM 550.00
TOTAL COST	=	DM 1380.00

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Bldg. 101, Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO E10

PROJECT TITLE: Dimmer/Timer Controls For Exterior Lighting FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 3 Mar 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1.	INVESTMENT COSTS:			
A.	CONSTRUCTION COST	DM 1,380		
B.	SIOH	DM 83		
C.	DESIGN COST	DM 83		
D.	TOTAL COST (1A+1B+1C)	DM 1,546		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 1,546

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.6	9.15	DM 380.6	11.59**	DM 4,411.6
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		9.15	DM 380.6		DM 4,412

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; 20 YEARS; REGION 5

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 4.06 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 4,412

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.85

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 9.60 %

ECO E14

GRAFENÖHR

PHOTOELECTRIC CONTROLS FOR

INTERIOR LIGHTING FIXTURES

Baker Engineers

S.O. No. 20058-45-32M

Subject: Greenville / Local Energy Audit

Greenville – ECO #14 — Sheet No. 1 of ____

Photoelectric Control of Interior Lighting — Drawing No. ____

Computed by CEH — Checked By ____ — Date 30 April 1993

- FROM ROBERT A RUNDQUIST'S ARTICLE "DAYLIGHTING CONTROLS: ORPHAN OF HVAC DESIGN" IN THE NOVEMBER 1991 ASHRAE JOURNAL, "A WINDOW LETTING IN A FAIR AMOUNT OF DAYLIGHT ... (WITH) ... A DIMMING-TO-30%-POWER LIGHTING CONTROL, ONE MIGHT FIND A 40% ANNUAL LIGHTING SAVINGS." THE BASIS FOR MR. RUNDQUIST'S ANALYSIS IS A TYPICAL OFFICE BUILDING WITH THE PHOTOELECTRIC CONTROLS MODULATING THE LIGHTING IN A 15' WIDE STRIP AROUND THE BUILDING PERIMETER.

- THE DINING AREA OF BUILDING 101 OPERATES WITH THE LIGHTS ON FOR THE FOLLOWING HOURS:

	MON, TUES WED, FRI	THURS	SAT, SUN
BREAKFAST	0500 - 0845	0500 - 0800	0630 - 0930
LUNCH	1045 - 1400	1045 - 1400	1130 - 1430
DINNER	1600 - 1900	1600 - 1900	1530 - 1830
TOTAL HRS LIGHTS ARE TURNED ON	10 HRS	9 1/4	9 HRS

← CHART ASSUMES THAT LIGHTS ARE TURNED ON 1/2 HR PRIOR TO MEALS AND TURNED OFF 1 HR AFTER MEALS

TOTAL NO. HRS BLDG 101 LIGHTS ARE TURNED ON =

$$(4 \times 10) + (1 \times 9\tfrac{1}{4}) + (2 \times 9) = 67\tfrac{1}{4} \text{ HRS/WEEK}$$

Baker Engineers

S.O. No. 20008-45-3?M

Subject: [illegible] / [illegible] ENERGY AUDIT

[illegible] ECO # 14

PHOTOELECTRIC CONTROL OF INTERIOR LIGHTING

Sheet No. 2 of

Drawing No.

Computed by [illegible] Checked By

Date 30 APR. [illegible]3

- LIGHTING WITHIN A 15' WIDE STRIP PARALLELING THE WINDOWS IN THE DINING AREA :

9	- 3x36 FIXTURES	=	972 WATTS
14	- 1x36 FIXTURES	=	504 WATTS
23	- 1x13 BALLASTS	=	299 WATTS
			1775 WATTS

- ASSUMING THAT THE 40% SAVINGS PROJECTED IN THE RENQUIST ARTICLE IS LIBERAL, USE A 35% ESTIMATE OF SAVINGS FOR THIS PROJECT. ALSO

67.25 HRS/WEEK × 52 WEEKS = 3497 SAY 3500 HRS/YR

$$\text{SAVINGS} = 35\% \times 1775 \text{ WATTS} \times \frac{3500 \text{ HRS}}{\text{YR}} \times \frac{3413 \text{ BTU}}{\text{WATT}} \times \frac{\text{MMBTU}}{10^6 \text{ BTU}} = 7.42 \text{ MMBTU/YR}$$

- ESTIMATED COST

PHOTOELECTRIC CELL CONTROLLERS	2 @ DM 246	=	492
DIMMER	2 @ DM 40	=	80
ELECTRONIC BALLASTS *	32 @ DM 75	=	2400
INSTALLATION	4 CKTS @ DM 50	=	200
			DM 3172

* 2 BALLAST / 3 TUBE FIXTURE ; 1 BALLAST / 1 TUBE FIXTURE

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Grafenwöhr, Germany REGION NO. 5 PROJECT NO ECO E14

PROJECT TITLE: Photoelectric Controls for Interior Lighting Fixtures FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 30 Apr 92 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 3,172		
B.	SIOH	DM 190		
C.	DESIGN COST	DM 190		
D.	TOTAL COST (1A+1B+1C)	DM 3,552		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 3,552

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.6	7.42	DM 308.7	11.59**	DM 3,577.5
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		7.42	DM 308.7		DM 3,578

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 11.51 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 3,578

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.01

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.04 %

ECO H10

VILSECK

DUCT INSULATION REPAIR

S.O. No. [illegible]

Subject: Grafenwöhr / Vilseck Energy Audit

ECO H1C - Vilseck

Duct Insulation Repair

Sheet No. 1 of

Drawing No.

Computed by C.E.V. Checked By

Date 16 March 2003

Baker

- Duct insulation at Grafenwöhr Building 101 is foil-skrim-kraft (FSK) backed fiberglass external duct wrap type insulation. Insulation appears to be 5 cm (2") thick. Assuming an insulation density of 16 kg/m³ (1#/ft³), the installed R-value (25% compression) is 5.3 °F·ft²·hr/Btu
- Since $U = 1/R$, the U-value for the assumed duct insulation will be: $1/5.3 = 0.189$ Btu/hr·ft²·°F
- Assuming a 110°F supply air temperature (heating season) and a 70°F ambient air temperature in the mechanical room and/or the ceiling plenum, one square foot of insulation will permit the following heat transfer

$$Q = UA\Delta t$$
$$= (0.189 \text{ Btu/hr}\cdot\text{ft}^2\cdot{}^\circ\text{F})(1\text{ ft}^2)(110° - 70°)$$
$$= 7.50 \text{ Btu/hr}$$

- An uninsulated duct will have an R-value of

Inside air film (moving air)	R =	0.17
Ductwork	R =	0.00
Outside air film (still air) (average of four orientations)	R =	1.62
	R_T =	1.79

- And a U-value of $1/1.79 = 0.559$ Btu/hr·ft²·°F
- Therefore, the heat transfer through one square foot of uninsulated ductwork will be:

$$Q = (0.559 \text{ Btu/hr}\cdot\text{ft}^2\cdot{}^\circ\text{F})(1\text{ ft}^2)(40°\text{F})$$
$$= 22.36 \text{ Btu/hr}$$

S.O. No. 20098 · 25 · 32M

Subject: GRAFENWOHR / VILSECK ENERGY AUDIT

ECO H10 - VILSECK

DUCT INSULATION REPAIR

Sheet No. 2 of

Drawing No.

Computed by CEM Checked By Date 16 MARCH 1993

Baker

- THE DIFFERENCE (SAVINGS) IN HEAT TRANSFER FOR ONE SQUARE FOOT OF DUCTWORK WILL BE :

$$\begin{array}{r} 22.36 \text{ Btu/hr} \\ -\ 7.50 \\ \hline 14.86 \text{ Btu/hr} \end{array}$$

- ASSUMING THAT THE HEATING SYSTEMS OPERATE FROM MID-SEPTEMBER TO MID-MAY (30 WEEKS); AND THAT THEY OPERATE 2/3 OF THE TIME BETWEEN 700 HOURS (AVG BREAKFAST START - 2HRS) AND 1930 HRS (AVG. DINNER CLOSING TIME + 1½ HRS CLEAN-UP TIME); AND THAT THE SYSTEMS OPERATE 1/3 OF THE TIME FOR THE REMAINDER OF THE DAY - THE AVERAGE RUNNING TIME FOR THE HEATING SYSTEM IS :

$$30 \text{ WEEKS} \times \frac{7 \text{ DAYS}}{\text{WEEK}} \times \frac{14\frac{1}{2} \text{ HRS}}{\text{DAY}} @ \tfrac{2}{3} \text{ OPERATING TIME} = 2030 \text{ HRS}$$

$$30 \text{ WEEKS} \times \frac{7 \text{ DAYS}}{\text{WEEK}} \times \frac{9\frac{1}{2} \text{ HRS}}{\text{DAY}} @ \tfrac{1}{3} \text{ OPERATING TIME} = 665 \text{ HRS}$$

2695 HRS

SAY 2700 HRS / YR

- ANNUAL ENERGY SAVINGS = 2700 HRS × 14.86 BTU/HR = 40,122 BTU/ft² OF INSULATION. IN SI UNITS, THE ANNUAL ENERGY SAVINGS PER SQUARE METER OF DUCT INSULATION IS :

$$\frac{40{,}122 \text{ BTU}}{ft^2} \times \frac{0.0929 ft^2}{1 m^2} \times \frac{W}{0.293 \text{BTUH}} \times \frac{1 \text{ kW}}{1000 W} = 12.72 \text{ kW}$$

- THE ESTIMATED AREA OF DUCTWORK INSULATION IN NEED OF REPAIR IS 32 m². THIS DOES NOT INCLUDE THE LARGE AMOUNT OF INSULATION WHICH HAS FALLEN DOWN AND IS ALREADY SCHEDULED TO BE RE-INSTALLED WITH WELDED (NOT ADHESIVE TYPE) INSULATION PINS.

S.O. No. 20098 - 25 - 32M

Subject: GRAFENWOHR / VILSECK ENERGY AUDIT

ECO H10 - VILSECK

DUCT INSULATION REPAIR

Sheet No. 3 of

Drawing No.

Computed by CEM Checked By

Date 16 MARCH 1995

Baker

- BASED ON $32 m^2$ OF REPLACEMENT INSULATION, THE ANNUAL ENERGY SAVINGS WILL BE $32 m^2 \times 12.72 \text{ kW}/m^2 = 407 \text{ kW}$

- INSULATION COSTS WILL BE

  $32 m^2 \times$ DM 68 = DM 2,176.00

- ENERGY COST SAVINGS WILL BE:

  407 kW × DM 0.05/kW = DM 20.35

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO H10

PROJECT TITLE: Duct Insulation Replacement/Repair FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 17 Mar 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 2,176		
B.	SIOH	DM 130		
C.	DESIGN COST	DM 130		
D.	TOTAL COST (1A+1B+1C)	DM 2,436		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 2,436

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 36.07	1.4	DM 50.5	17.21***	DM 869.1
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		1.4	DM 50.5		DM 869.1

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS REGION HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 48.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 869.1

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.36

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): - 1.22 %

ECO H17

VILSECK

PIPE INSULATION

S.O. No. 20098-40-00M.

Subject: Greenwood / Village Energy Audit

ECO H17 - Pipe Insulation

Sheet No. 1 of 5

Drawing No.

Computed by CEM Checked By Date May 3 [illegible]

- ASSUMPTIONS:

1. AVERAGE WATER TEMPERATURE = 57.5°C
(BASED ON A HOT WATER RESET SCHEDULE OF 85°C SUPPLY TEMPERATURE AT -18°C OUTDOOR AIR TEMPERATURE AND 40°C SUPPLY TEMPERATURE AT 16°C OUTDOOR AIR TEMPERATURE ; AND A WATER TEMPERATURE DROP OF 10°C ACROSS THE FINNED TUBE RADIATION (i.e. AVG. SUPPLY TEMPERATURE = (85°C + 40°C)/2 = 62.5°C ; AVG. RETURN TEMPERATURE = [(85-10) + (40-10)]/2 = 52.5°C ; ∴ AVG. WATER TEMPERATURE (62.5°C + 52.5°C)/2 = 57.5°C)

2. INDOOR AMBIENT TEMPERATURE = 72°F

3. INSULATION IS FIBERGLASS PIPE INSULATION W/ A JACKET OF WHITE KRAFT PAPER BONDED TO ALUMINUM FOIL AND REINFORCED WITH GLASS FIBERS.

4. INSULATION THICKNESS IS AS FOLLOWS:

   PIPE SIZES UP TO 32mm - 13mm INSULATION
   PIPE SIZES FROM 38mm TO 51mm - 25mm INSULATION
   PIPE SIZES OVER 51mm - 38 mm INSULATION

PIPE SIZE (NOM)	INSULATION THICKNESS	BARE PIPE HEAT LOSS PER LINEAR FOOT	INSULATED PIPE HEAT LOSS/FOOT	ENERGY SAVINGS PER FOOT	ENERGY SAVINGS W/METER
15mm	13 mm	32.9 BTUH/FT	8.2 BTUH/FT	24.7 BTUH/FT	23.7 W/M
20mm	13 mm	40.2 BTUH/FT	8.2 BTUH/FT	32.0 BTUH/FT	30.8 W/M
25mm	13 mm	49.3 BTUH/FT	11.0 BTUH/FT	38.3 BTUH/FT	36.8 W/M
32mm	13 mm	61.2 BTUH/FT	14.6 BTUH/FT	46.6 BTUH/FT	44.8 W/M
40mm	25 mm	68.5 BTUH/FT	9.1 BTUH/FT	59.4 BTUH/FT	57.1 W/M
50mm	25 mm	84.0 BTUH/FT	11.0 BTUH/FT	73.0 BTUH/FT	70.2 W/M
65mm	38mm	100.4 BTUH/FT	8.2 BTUH/FT	92.2 BTUH/FT	88.6 W/M
80mm	38 mm	119.6 BTUH/FT	11.0 BTUH/FT	108.6 BTUH/FT	104.4 W/M
100mm	38mm	135.1 BTUH/FT	11.0 BTUH/FT	124.1 BTUH/FT	119.3 W/M

HEAT LOSS VALUES IN CHART ARE BASED ON TABLES PUBLISHED BY OWENS-CORNING FIBERGLASS (PUB. NO. 3-IN-6496-E, OCT 1986). VALUES WERE ADJUSTED FOR 35.5°C (63.9°F) TEMPERATURE DIFFERENTIAL. SEE PAGES 2-4 OF CALCULATIONS.

S.O. No. 20098 · 45 · P2M

Subject: Greenwood / Village Energy Audit

500 H.P. · Pipe Insulation

Sheet No. 2 of 5

Drawing No.

Computed by CEN Checked By Date March 22, 1993

Baker

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1/2 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

THICK	150.F HEAT LOSS	150.F SURF TEMP	200.F HEAT LOSS	200.F SURF TEMP	300.F HEAT LOSS	300.F SURF TEMP	400.F HEAT LOSS	400.F SURF TEMP	500.F HEAT LOSS	500.F SURF TEMP	600.F HEAT LOSS	600.F SURF TEMP	650.F HEAT LOSS	650.F SURF TEMP	700.F HEAT LOSS	700.F SURF TEMP	750.F HEAT LOSS	750.F SURF TEMP	800.F HEAT LOSS	800.F SURF TEMP	850.F HEAT LOSS	850.F SURF TEMP
BARE	36		71		159		275		422		606		715		836		970		1119		1283	
0.5	9	91	16	98	34	115	57	134	85	155	120	179	141	192	164	207	190	221	218	237	250	254
1.0	6	85	12	90	24	99	40	109	60	121	85	135	99	142	115	151	133	159	153	169	176	179
1.5	5	83	9	86	20	92	32	98	48	106	68	115	80	120	93	126	107	132	123	138	141	145
2.0	4	82	8	84	17	89	29	94	43	99	60	106	71	110	82	114	95	119	109	124	125	129
2.5	4	81	7	83	15	86	25	89	37	93	52	98	61	101	71	104	82	108	95	111	109	115
3.0	3	81	7	82	14	85	23	88	35	91	49	95	58	98	67	100	77	103	89	106	102	110
3.5	3	81	6	82	13	84	22	87	33	90	47	93	55	95	64	98	73	100	84	103	97	106
4.0	3	81	6	82	13	83	21	86	32	88	45	92	52	93	61	95	70	97	81	100	92	102
4.5	3	80	6	81	12	83	20	85	30	87	43	90	50	92	58	93	67	95	77	97	89	100
5.0	3	80	5	81	12	83	20	84	29	86	41	89	48	90	56	92	65	94	75	96	86	98
5.5	3	80	5	81	11	82	19	84	28	86	40	88	47	89	55	91	63	92	73	94	83	96
6.0	3	80	5	81	11	82	18	83	28	85	39	87	45	88	53	90	61	91	70	93	80	94

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 3/4 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

THICK	150.F HEAT LOSS	150.F SURF TEMP	200.F HEAT LOSS	200.F SURF TEMP	300.F HEAT LOSS	300.F SURF TEMP	400.F HEAT LOSS	400.F SURF TEMP	500.F HEAT LOSS	500.F SURF TEMP	600.F HEAT LOSS	600.F SURF TEMP	650.F HEAT LOSS	650.F SURF TEMP	700.F HEAT LOSS	700.F SURF TEMP	750.F HEAT LOSS	750.F SURF TEMP	800.F HEAT LOSS	800.F SURF TEMP	850.F HEAT LOSS	850.F SURF TEMP
BARE	44		87		195		337		518		745		880		1030		1196		1380		1584	
0.5	9	89	17	96	35	110	58	126	87	145	123	166	144	177	167	190	193	203	222	217	255	232
1.0	7	86	14	91	29	102	49	114	73	128	102	144	120	153	139	162	161	173	185	184	212	195
1.5	6	84	11	87	23	93	38	101	56	110	79	120	93	126	108	132	125	139	143	146	164	154
2.0	5	83	9	85	20	90	33	95	49	102	69	110	80	114	93	119	108	124	124	129	142	135
2.5	4	82	8	83	17	86	28	90	42	95	59	100	69	103	80	107	92	110	106	114	122	119
3.0	4	81	7	82	16	85	26	89	39	92	55	97	64	100	74	102	86	106	99	109	113	113
3.5	4	81	7	82	15	84	25	87	37	91	52	95	60	97	70	99	81	102	93	105	107	108
4.0	3	81	7	82	14	84	23	86	35	89	49	93	56	95	67	97	77	99	89	102	102	104
4.5	3	81	6	81	13	83	22	85	33	88	47	91	55	93	64	95	74	97	85	99	97	101
5.0	3	80	6	81	13	83	21	85	32	87	45	90	53	91	62	93	71	95	82	97	94	99
5.5	3	80	6	81	12	83	21	84	31	86	44	89	51	90	60	92	69	93	79	95	91	97
6.0	3	80	6	81	12	82	20	84	30	86	42	88	49	89	57	90	66	92	76	94	87	95

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

THICK	150.F HEAT LOSS	150.F SURF TEMP	200.F HEAT LOSS	200.F SURF TEMP	300.F HEAT LOSS	300.F SURF TEMP	400.F HEAT LOSS	400.F SURF TEMP	500.F HEAT LOSS	500.F SURF TEMP	600.F HEAT LOSS	600.F SURF TEMP	650.F HEAT LOSS	650.F SURF TEMP	700.F HEAT LOSS	700.F SURF TEMP	750.F HEAT LOSS	750.F SURF TEMP	800.F HEAT LOSS	800.F SURF TEMP	850.F HEAT LOSS	850.F SURF TEMP
BARE	54		106		239		413		637		919		1085		1271		1477		1706		1959	
0.5	12	92	22	100	47	119	78	139	116	162	164	188	192	202	224	217	259	234	298	251	342	269
1.0	8	86	15	90	31	99	51	110	75	123	106	137	124	145	145	153	167	163	192	172	220	183
1.5	6	84	12	87	25	93	41	100	61	109	86	119	101	125	117	131	136	138	156	145	179	152
2.0	5	82	10	85	21	89	35	95	53	101	74	109	87	113	101	118	117	123	134	128	154	134
2.5	5	82	9	84	19	87	32	92	47	97	67	103	78	106	91	110	105	114	121	118	138	123
3.0	4	81	8	83	18	86	29	90	44	94	62	99	72	102	84	105	97	108	111	112	128	116
3.5	4	81	8	82	17	85	27	88	41	92	58	96	68	99	79	101	91	104	104	107	120	111
4.0	4	81	7	82	16	84	26	87	39	90	55	94	64	96	74	98	86	101	99	104	113	107
4.5	4	81	7	82	15	84	25	86	37	89	52	92	61	94	71	96	82	98	94	101	107	103
5.0	3	81	7	81	14	83	24	85	35	88	50	91	58	92	68	94	78	96	90	99	103	101
5.5	3	80	6	81	14	83	23	85	34	87	48	90	56	91	65	93	76	95	87	97	100	99
6.0	3	80	6	81	13	82	22	84	33	86	46	89	54	90	63	91	73	93	84	95	96	97

S.O. No. 20098 - - S - B2 - 1

Subject: Gutenberg / Village Energy Audit

ECO H17 - Pipe Insulation

Sheet No. 3 of 5

Drawing No.

Computed by CEM Checked By

Date March 22, 1993

Baker

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1 1/4 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	67		131		295		511		789		1141		1349		1581		1839		2126		2443	
0.5	18	97	34	109	72	135	119	164	179	195	253	231	297	250	345	270	400	291	461	313	529	337
1.0	10	87	19	93	39	104	65	118	97	133	137	150	161	160	187	170	216	181	248	193	285	206
1.5	7	84	13	87	28	93	46	101	68	109	96	120	113	125	131	131	151	138	174	145	199	153
2.0	6	83	12	86	25	91	42	98	63	105	88	114	103	119	120	124	139	130	160	136	183	143
2.5	6	82	11	84	22	88	37	93	55	99	78	106	91	110	106	114	122	119	141	124	161	129
3.0	5	82	10	83	20	87	34	91	50	96	71	101	83	105	97	108	111	112	128	116	147	121
3.5	5	81	9	83	19	86	31	89	47	93	66	98	77	101	90	104	103	107	119	111	136	115
4.0	4	81	8	82	18	85	29	88	44	91	62	96	72	98	84	101	97	103	112	107	128	110
4.5	4	81	8	82	17	84	28	87	41	90	58	93	68	96	79	98	92	100	105	103	121	106
5.0	4	81	8	82	16	84	27	86	40	89	56	92	65	94	76	96	88	98	101	100	115	103
5.5	4	81	7	81	15	83	25	85	38	88	54	91	63	92	73	94	84	96	97	98	111	101
6.0	4	80	7	81	15	83	24	85	36	87	51	89	60	91	70	93	81	94	93	96	106	98

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 1 1/2 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	75		148		334		579		894		1294		1530		1795		2089		2415		2777	
0.5	17	93	31	103	66	124	109	147	162	173	229	202	269	218	313	235	362	253	417	272	478	292
1.0	10	86	19	91	40	102	66	114	98	128	139	144	162	153	189	163	218	173	251	184	287	195
1.5	8	84	15	87	32	95	52	103	78	113	109	124	128	130	149	137	172	145	197	152	226	161
2.0	6	82	12	85	25	89	41	95	61	101	86	109	101	113	117	117	135	122	155	128	178	134
2.5	6	82	11	84	22	87	37	92	55	97	78	103	91	107	106	111	122	115	140	119	161	124
3.0	5	81	10	83	21	86	34	90	51	94	72	100	84	103	97	106	113	109	129	113	148	117
3.5	5	81	9	82	19	85	32	88	48	92	67	97	78	99	91	102	105	105	121	108	139	112
4.0	4	81	9	82	18	84	30	87	45	90	63	94	74	97	85	99	99	102	114	105	130	108
4.5	4	81	8	82	17	84	29	86	43	89	60	93	70	95	81	97	94	99	108	102	124	105
5.0	4	81	8	81	16	83	27	86	41	88	57	91	67	93	78	95	90	97	104	100	119	102
5.5	4	80	7	81	16	83	26	85	39	87	55	90	64	92	74	93	86	95	99	97	113	100
6.0	4	80	7	81	16	83	26	85	39	87	55	90	64	92	74	93	86	95	99	97	113	100

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 2 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE — 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH — 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	92		181		409		710		1099		1593		1886		2214		2578		2984		3433	
0.5	18	92	34	101	71	121	118	142	176	166	249	193	291	208	339	224	392	241	451	258	517	277
1.0	12	87	22	92	46	103	77	115	114	130	161	146	188	156	219	165	253	176	291	187	334	199
1.5	9	84	17	88	36	95	59	104	88	114	124	125	145	132	169	139	195	146	224	154	257	163
2.0	8	83	14	86	30	91	50	98	74	105	104	114	122	119	142	124	164	130	188	136	216	143
2.5	7	82	13	84	27	89	44	94	66	100	92	107	108	111	126	116	145	120	167	125	191	131
3.0	6	82	12	83	24	87	40	91	60	97	84	103	98	106	114	110	132	114	151	118	173	123
3.5	6	81	11	83	22	86	37	90	55	94	78	99	91	102	105	105	122	109	140	112	160	116
4.0	5	81	10	82	21	85	34	88	51	92	72	96	84	99	98	102	113	105	130	108	149	111
4.5	5	81	9	82	20	84	32	87	48	90	68	94	80	97	93	99	107	102	123	105	141	108
5.0	5	81	9	82	19	84	31	86	46	89	65	93	76	95	88	97	102	99	117	102	134	105
5.5	4	81	8	81	18	83	29	85	44	88	62	91	72	93	84	95	97	97	111	99	127	102
6.0	4	80	8	81	17	83	28	85	42	87	59	90	69	92	81	94	93	95	107	98	123	100

S.O. No. 20058.45.32M

Subject: [illegible] / [illegible]

[illegible] Insulation

Sheet No. 4 of 5

Drawing No.

Computed by CEM Checked By Date March 22, 1993

Baker

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 2 1/2 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	110		215		487		846		1312		1904		2256		2650		3089		3576		4117	
0.5	21	93	40	102	83	122	138	144	206	169	290	196	340	212	396	228	458	245	528	263	605	282
1.0	14	87	26	92	54	104	88	117	132	132	185	149	217	158	252	169	292	179	335	191	384	204
1.5	9	84	18	87	37	93	61	101	90	110	127	120	149	126	173	132	200	139	230	146	263	154
2.0	8	83	15	85	32	90	52	96	78	103	110	112	129	116	149	121	173	127	198	133	227	139
2.5	7	82	14	84	28	88	47	93	70	99	98	106	115	110	133	114	154	118	177	123	203	129
3.0	7	82	12	83	26	87	43	91	64	96	90	102	105	105	122	109	141	113	162	117	185	121
3.5	6	81	11	83	24	86	39	89	59	93	82	98	96	101	112	104	129	108	149	111	170	115
4.0	6	81	11	82	22	85	37	88	55	92	77	96	91	99	105	101	121	104	140	107	160	111
4.5	5	81	10	82	21	84	35	87	52	90	73	94	86	96	100	99	115	102	132	104	151	108
5.0	5	81	9	82	20	84	33	86	49	89	69	92	81	94	94	97	108	99	ᴛ25	101	143	104
5.5	5	81	9	82	20	84	33	86	49	89	69	92	81	94	94	97	108	99	125	101	143	104
6.0	5	81	9	81	19	83	32	86	47	88	66	91	77	93	90	95	104	97	120	99	137	102

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 3 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	131		258		583		1015		1575		2290		2715		3190		3721		4311		4966	
0.5	28	94	51	105	107	127	177	152	264	179	374	210	438	227	510	245	590	263	679	283	779	304
1.0	17	87	30	93	64	105	105	119	156	135	220	153	258	163	300	174	346	185	399	198	457	211
1.5	12	85	23	89	48	97	79	106	117	117	165	130	193	137	224	145	259	153	297	162	341	172
2.0	10	83	19	86	40	93	65	100	97	108	137	118	160	124	186	130	215	136	247	143	283	151
2.5	9	83	16	85	34	90	57	96	85	103	119	111	139	115	162	120	187	125	215	131	246	137
3.0	8	82	15	84	31	88	51	93	76	99	107	105	125	109	145	113	168	118	193	123	221	128
3.5	7	82	13	83	28	87	46	91	69	96	97	101	113	104	131	108	152	112	174	116	200	120
4.0	7	81	12	83	26	86	43	89	64	93	90	98	105	101	122	104	141	108	162	111	185	115
4.5	6	81	12	82	24	85	40	88	60	92	84	96	99	99	115	101	132	104	152	108	174	111
5.0	6	81	11	82	23	84	38	87	56	90	79	94	92	96	107	99	124	101	142	104	163	107
5.5	5	81	10	82	22	84	36	86	53	89	75	93	88	95	102	97	118	99	136	102	155	105
6.0	5	81	10	81	21	83	34	86	51	88	72	92	84	93	98	95	113	97	130	100	149	102

FIBERGLAS® PIPE INSULATION WITH ASJ OR NO-WRAP — 3 1/2 IRON PIPE SIZE
HORIZONTAL CYLINDER — HEAT LOSS BTU HOUR PER FOOT LENGTH
80.F AMBIENT TEMPERATURE 0.90 SURFACE EMITTANCE
0.0 WIND VELOCITY, MPH 0.85 BARE SURFACE EMITTANCE

	150.F		200.F		300.F		400.F		500.F		600.F		650.F		700.F		750.F		800.F		850.F	
THICK	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP	HEAT LOSS	SURF TEMP
BARE	148		291		658		1148		1783		2595		3078		3619		4223		4895		5641	
0.5	31	95	57	105	120	128	198	153	297	181	419	212	492	229	572	247	662	266	763	286	875	307
1.0	15	86	29	91	59	101	98	112	146	125	206	141	241	149	280	158	323	168	372	178	426	189
1.5	12	84	23	88	47	95	78	103	116	113	164	125	192	131	223	138	257	146	296	154	339	162
2.0	10	83	19	86	40	92	66	98	99	106	139	115	163	120	189	126	218	132	251	138	287	145
2.5	9	82	17	85	36	89	59	95	87	101	123	109	143	113	167	118	192	123	221	128	253	134
3.0	8	82	15	84	32	88	52	92	78	97	109	104	128	107	149	111	172	115	197	120	226	125
3.5	7	82	14	83	29	86	48	90	72	95	101	100	118	104	137	107	158	111	182	115	208	119
4.0	7	81	13	83	27	86	45	89	67	93	94	98	110	101	128	104	147	107	169	110	194	114
4.5	6	81	12	82	25	85	42	88	62	91	87	95	102	98	118	100	137	103	157	106	180	110
5.0	6	81	12	82	25	85	42	88	62	91	87	95	102	98	118	100	137	103	157	106	180	110
5.5	6	81	11	82	24	84	39	87	59	90	83	94	97	96	112	98	130	101	149	104	171	107
6.0	6	81	11	82	23	84	38	86	56	89	79	93	92	95	107	97	124	99	142	102	163	104

Baker Engineers

S.O. No. 20098-45-BRM

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

VILSECK ECO H17 Sheet No. 5 of 5

PIPE INSULATION Drawing No.

Computed by CEM Checked By Date 3 MAY 1993

- ESTIMATED INSULATION REPLACEMENT REQUIREMENTS:

43 m OF PIPE INSULATION (DN 15 - DN 100)	=	43 M
32 FITTINGS @ 0.25 M EA.	=	8 M
		51 M

- AVG HEAT LOSS FOR (DN 15 - DN 100) PIPING =

  (23.7 + 30.8 + 36.8 + 44.8 + 57.1 + 70.2 + 88.6 + 104.4 + 119.3) / 9 = 64 W/M

- ANNUAL ENERGY SAVINGS =

$$= 5\,\text{MONTHS} \times \frac{1\,\text{YEAR}}{12\,\text{MONTHS}} \times \frac{8760\,\text{HRS}}{1\,\text{YEAR}} \times 51\,\text{METERS} \times \frac{64\,\text{W}}{\text{METER}} \times \frac{3.413\,\text{BTU}}{\text{W-HR}} \times \frac{\text{MMBTU}}{10^6\,\text{BTU}}$$

$= 40.66$ MMBTU

- ESTIMATED CONSTRUCTION COST

43M × DM 80/M	=	DM 3440
32 FITTINGS × DM 160/FITTING	=	DM 5120
		DM 8560

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO H17

PROJECT TITLE: HVAC Pipe Insulation FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 3 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 8,560		
B.	SIOH	DM 514		
C.	DESIGN COST	DM 514		
D.	TOTAL COST (1A+1B+1C)	DM 9,588		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 9,588

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 36.07	40.7	DM 1468.0	17.21***	DM 25,265.1
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		40.7	DM 1468		DM 25,265

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 6.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 25,265

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.64

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 9.16 %

ECO H24

VILSECK

VESTIBULE HEATING

Baker Engineers

S.O. No. 20098-45-3RM

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

VILSECK ECO H24 Sheet No. 1 of

DISCONNECT VESTIBULE HEATERS Drawing No.

Computed by CEM Checked By Date 4 MAY 1993

- THERE ARE TWO AIR CURTAIN TYPE HEATERS LOCATED IN THE MAIN TROOP ENTRY CORRIDOR OF BUILDING 603. ONE AIR CURTAIN IS LOCATED OVER EACH ENTRY DOOR. THESE DEVICES ARE PROBABLY NOT ORIGINAL TO THE BUILDING AS THEY ARE NOT SHOWN ON THE DESIGN DRAWINGS

- TYPICALLY, 60" WIDE (DOUBLE DOOR WIDTH) AIR CURTAINS HAVE TWO 1/3 HP BLOWER MOTORS AND ARE RATED FOR APPROXIMATELY 65000 BTUH

- ASSUMING THAT THE AIR CURTAINS OPERATE FOR 33% OF THE MEAL-TIME HOURS (DUE TO HEAVY FOOT TRAFFIC THROUGH THE ENTRY DOORS AND CORRIDOR) DURING THE FOUR COLDEST MONTHS; AND HALF AS MANY HOURS DURING THE TWO MONTHS ON EITHER SIDE OF THE COLDEST MONTHS (6 MOS. TOTAL OPERATION, ANNUALLY)

$$17 \text{ WEEKS} \times 32.5 \text{ HRS/WEEK} \times 33\% = 184.2$$
$$9 \text{ WEEKS} \times 32.5 \text{ HRS/WEEK} \times 16.7\% = \underline{48.8}$$
$$233.0$$

- ENERGY USE:

$$2 \text{ UNITS} \times \frac{233 \text{ HRS}}{\text{YEAR}} \times \frac{65000 \text{ BTU}}{\text{UNIT-HR}} \times \frac{\text{MMBTU}}{10^6 \text{ BTU}} = 30.3 \text{ MMBTU}$$

$$2 \text{ UNITS} \times \frac{233 \text{ HRS}}{\text{YEAR}} \times \frac{2 \text{ MOTORS}}{\text{UNIT}} \times \frac{1/3 \text{ HP}}{\text{MOTOR}} \times \frac{2545 \text{ BTU}}{\text{MOTOR} \times 80\% \text{ EFFICIENCY}} \times \frac{\text{MMBTU}}{10^6 \text{ BTU}} = \frac{1.0 \text{ MMBTU}}{\text{YR}}$$

- CONSTRUCTION COST ESTIMATE

DEMOLITION OF MECH'L & ELECTRICAL DEVICES = 20 HRS × 50/HR =	DM 1000
REPLACEMENT OF TRIM @ DOORS	DM 200
	DM 1200

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO H24

PROJECT TITLE: Disconnect Vestibule Heaters FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 4 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 1,200		
B.	SIOH	DM 72		
C.	DESIGN COST	DM 72		
D.	TOTAL COST (1A+1B+1C)	DM 1,344		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 1,344

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.02	1.0	DM 41.0	11.59**	DM 475.4
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.***	OTHER	DM 36.07	30.3	DM 1,092.9	17.21****	DM 18,809.2
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		31.3	DM 1,134		DM 19,284.6

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

*** OTHER FUEL IS DISTRICT HOT WATER

**** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 1.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 19,285

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 14.35

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 18.82 %

ECO P5

VILSECK

STORAGE TANK INSULATION

Baker Engineers

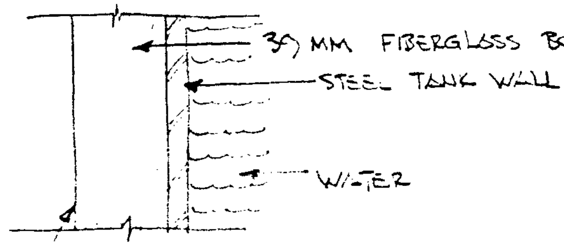
S.O. No. 20098-45-32M

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

VILSECK ECO P5 — Sheet No. 1 of

STORAGE TANK INSULATION — Drawing No.

Computed by CEM — Checked By — Date 4 MAY 1993

- TANK WATER TEMPERATURE = 60°C (140°F)
- MECHANICAL ROOM TEMPERATURE = 22°C (72°F)
- 

- OUTSIDE AIR FILM

- OUTSIDE AIR FILM (STILL AIR) R = 1.46

  INSULATION R = 4.39

  STEEL R = 0.00

  R_T = 5.85

  $U = 1/R_T$ = 0.171 BTU/°F-FT²-HR

  = 0.971 W/°C·M²

- ESTIMATED AMOUNT OF INSULATION TO BE REPLACED = 8 m²
- ENERGY SAVINGS = $8\,m^2 \times \frac{0.971\,W}{°C \cdot m^2} \times (60°C - 22°C) = 295.2\,W$
- ASSUMING THAT DOMESTIC HOT WATER IS STORED AT 60°C THROUGHOUT THE YEAR:

$$\frac{365\,DAYS}{YEAR} \times \frac{24\,HRS}{DAY} \times 295.2\,W \times \frac{3.413\,BTU}{KWH} \times \frac{MMBTU}{10^6\,BTU} = 8.83\,MMBTU/YEAR$$

- ESTIMATED CONSTRUCTION COST = $8\,m^2 \times \frac{DM\,98.00}{m^2}$ = DM 784⁻

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO P5

PROJECT TITLE: Storage Tank Insulation FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 4 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1.	INVESTMENT COSTS:			
A.	CONSTRUCTION COST	DM 784		
B.	SIOH	DM 47		
C.	DESIGN COST	DM 47		
D.	TOTAL COST (1A+1B+1C)	DM 878		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 878

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 36.07	8.83	DM 318.5	17.21***	DM 5,481.4
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		8.83	DM 318.5		DM 5,481

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

APPENDIX F

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 2.8 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 5,481

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 6.24

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.97 %

ECO P7

VILSECK

FLOW RESTRICTORS

Baker Engineers

S.O. No. 20098-45-BRM

Subject: GRAFENWOHR / VILSECK ENERGY AUDIT

VILSECK ECO P7 — Sheet No. 1 of

FLOW RESTRICTORS — Drawing No.

Computed by CEM — Checked By — Date 4 MAY 1993

- DOMESTIC HOT WATER TEMPERATURE = 60°C (140°F)
- FLOW RESTRICTING AERATOR FITTINGS REDUCE LAVATORY FLOW FROM 3GPM TO 0.5GPM
- APPROXIMATELY 1600 MEALS ARE SERVED EACH DAY. ASSUMING THAT 1/3 OF ALL DINERS WASH THEIR HANDS AND THAT ON THE AVERAGE FLOW IS MAINTAINED FOR 20 SECONDS/HANDWASHING

1600 DINERS/DAY × 1/3 × 20 SECONDS × 1MIN/60SECONDS = 177.8 MINUTES/DAY

ALSO, ASSUME THAT THE KITCHEN STAFF (80 PEOPLE) WASHES THEIR HANDS AT LEAST ONCE EACH DAY FOR 60 SECONDS/HANDWASHING

80 STAFF MEMBERS × 1 MINUTE EA. = 80 MINUTS

TOTAL LAVATORY USE = 178 MINUTES + 80 MINUTES = 258 SAY 260 MIN/DAY

260 MIN/DAY × 350 DAYS/YR = 91,000 MINUTES/YEAR

- IF LAVATORY FLOW IS REDUCED FROM 3GPM TO 0.5GPM THE ANNUAL WATER SAVINGS WILL BE

91,000 MIN × (3-0.5 GAL/MIN) = 227,500 GALLONS

- ASSUMING THAT 2/3 OF THE WATER USED FOR HANDWASHING IS HOT WATER WHICH MUST BE HEATED FROM 10°C (50°F) TO 60°C (140°F)

$$2/3 \times \frac{227{,}500\ \text{GALLONS}}{\text{YR}} \times \frac{8.3^{\#}}{\text{GAL}} \times \frac{1\ \text{BTU}}{1^{\#}\text{-}^{\circ}\text{F}} \times (140^{\circ}\text{F}-50^{\circ}\text{F}) \times \frac{\text{MMBTU}}{10^{6}\ \text{BTU}} = 113.3\ \text{MMBTU/YEAR}$$

- CONSTRUCTION COST ESTIMATE:

14 LAVATORIES × DM 4.80 EA = DM 67.2

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO P7

PROJECT TITLE: Flow Restrictors FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 4 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 67.2		
B.	SIOH	DM 4.0		
C.	DESIGN COST	DM 4.0		
D.	TOTAL COST (1A+1B+1C)	DM 75.2		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 75.2

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 36.07	113.3	DM 4,086.7	17.21***	DM 70,332.6
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		113.3	DM 4,087		DM 70,333

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 0.02 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 70,333

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 935.3

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 46.41 %

ECO P8

VILSECK

AUTOMATIC SHUT-OFF FAUCETS

Baker Engineers

S.O. No. 20098-45-BRM

Subject: Grafenwöhr/Vilseck Energy Audit

Vilseck ECO P8 — Sheet No. 1 of

Automatic Shut-off Faucets — Drawing No.

Computed by CEM — Checked By — Date 4 May 1993

- Domestic hot water temperature = 60°C (140°F)
- Automatic flow faucets will shut off water flow after 4 seconds (most are adjustable from 2-15 seconds)
- Average handwashing will require 3 pushes of flow levers for a total of 12 seconds of flow (vs. 20 seconds of flow estimated for ECO P7). So the total flow duration will be reduced from the 91,000 min/yr estimated for ECO P7 to

$$\frac{12\text{ sec}}{20\text{ sec}} \times 91{,}000\text{ MIN/YR} = 54{,}600\text{ MIN}$$

For a savings of 91,000 - 54,600 = 36,400 minutes/yr

- At 0.5 GPM (flow restrictor installed)

$$36400\text{ MIN} \times 0.5\text{ GPM} = 18{,}200\text{ GAL/YR savings}$$

- With automatic shut-off faucets, 50% of the saved flow will be hot water, which will not have to be heated from 10°C to 60°C. Therefore, the energy savings will be:

$$0.50 \times 18{,}200\text{ GAL} \times \frac{8.3\#}{\text{GAL}} \times \frac{1\text{ BTU}}{\#\cdot°F} \times 90°F \times \frac{\text{MMBTU}}{10^6\text{ BTU}} = 6.8\text{ MMBTU}$$

- Construction Cost Estimate:

$$14\text{ LAVS} \times \text{DM } 180/\text{LAV} = \text{DM } 2520$$

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO P8

PROJECT TITLE: Automatic Shut-off Faucets FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 4 May 93 ECONOMIC LIFE: PREPARER Marstiller

1.	INVESTMENT COSTS:			
A.	CONSTRUCTION COST	DM 2,520		
B.	SIOH	DM 151		
C.	DESIGN COST	DM 151		
D.	TOTAL COST (1A+1B+1C)	DM 2,822		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 2,822

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM		DM		DM
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.**	OTHER	DM 36.07	6.8	DM 245.3	17.21***	DM 4,221.2
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		6.8	DM 245.3		DM 4,221

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** OTHER FUEL IS DISTRICT HOT WATER

*** DISCOUNT FACTOR FOR NATURAL GAS (SOURCE ENERGY); REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 11.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 4,221

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.50

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 6.11 %

ECO E1

VILSECK

LIGHTING LEVEL REDUCTION

S.O. No. 20058-25-BRM

Subject: Grafenwöhr / Vilseck Energy Audit

Vilseck ECO 5.1 — Sheet No. 1 of

Reduce Lighting Levels — Drawing No.

Computed by CEM Checked By Date 4 May 1993

Baker

Vilseck

From Gellmann calculations:

A reduction in illumination intensity (-15%) in the kitchen and food service area is possible by selective de-lamping

Space	Present lighting level	Proposed lighting level
Kitchen	450 - 700 lux	380 - 600 lux
Food Service Area	200 - 350 lux	170 - 300 lux

Space	Present installed wattage	Proposed installed wattage
Kitchen	102 × 36w = 3672w	87 × 36w = 3132w
Food Service Area	132 × 36w = 4752w	112 × 36w = 4032w
Ballasts	234 × 13w = 3042w	199 × 13w = 2587 w
Total wattage	11,466w	9751 w

- Total hourly savings = 11,466w - 9751w = 1715 w
- Based on 7600* hours of operation, the total annual energy savings is:

$$\frac{7600\,HRS}{YR} \times 1715W \times \frac{3.413\,BTU}{W-HR} \times \frac{MMBTU}{10^6\,BTU} = 44.48\,MMBTU$$

- Based on the Means Estimating Guide price for installing a fixture, the estimated cost of de-lamping 25 - 2 lamp fixtures will be:

25 fixtures × DM 72.18 = DM 1804.5

S.O. No. 20008-43-22V.

Subject: Griffenbuhl / Vilseck Energy Audit

Vilseck FOO FI

Reduce Lighting Levels

Sheet No. 2 of

Drawing No.

Computed by CEM Checked By

Date 4 May 1993

* Operating Hours (Kitchen/Food Service Area)

	MON, TUE, WED, FRI	THURS	SAT, SUN
BREAKFAST	0500-1045	0700-0830	0600-1130
LUNCH	0930-1500	1000-1530	0930-1500
DINNER	1500-2030	1400-1930	1400-1930
BAKING SHIFT	2200-0400	2200-0400	2200-0400
TOTAL NO. HRS LIGHTS ARE ON EA. DAY	0500-2030 = 15.5 2200-0400 = 6.0 21.5 HRS	0500-1030 = 5.5 1000-1930 = 9.5 2200-0400 = 6.0 21.0 21 HRS	0400-1730 = 13.5 2200-0400 = 6.0 19.5 HRS

CHART ASSUMES LIGHTS ARE TURNED ON 2HRS PRIOR TO MEALS AND TURNED OFF 2HRS AFTER MEALS.

$$52\text{ WKS} \times \left[(4 \times 21.5) + (21) + (2 \times 19.5)\right]$$

$= 7592$ HRS/YR SAY 7600 HRS/YR

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO E1

PROJECT TITLE: Reduce Lighting Levels FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 4 May 1993 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 1,804		
B.	SIOH	DM 108		
C.	DESIGN COST	DM 108		
D.	TOTAL COST (1A+1B+1C)	DM 2,020		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 2,020

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.02	44.5	DM 1,825.4	11.59**	DM 21,156.3
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		44.5	DM 1,825		DM 21,156

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 1.11 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 21,156

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 10.47

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 16.96 %

ECO E4

VILSECK

CONVERT TO FLUORESCENT LIGHTING

Baker Engineers

S.O. No. 20098-45-32M

Subject: GRAFENWÖHR/VILSECK ENERGY AUDIT

VILSECK ECO E4A — Sheet No. 1 of ____

CONVERT TO FLUORESCENT LIGHTING — Drawing No. ____

Computed by CEM — Checked By ____ — Date 6 MAY 1993

- THE EXISTING DINING ROOM LIGHTING FIXTURES HAVE INCANDESCENT LAMPS WITH A TOTAL CONNECTED WATTAGE OF:

18 FIXTURES × 12 LAMPS/FIXTURE × 40W/LAMP	=	8640 W
18 FIXTURES × 8 LAMPS/FIXTURE × 40W/LAMP	=	5760 W
24 FIXTURES × 1 LAMP/FIXTURE × 150W/LAMP	=	3600 W
		18,000 W

- BY REPLACING THE EXISTING LIGHTING FIXTURES WITH 94 NEW, SURFACE MOUNTED, FLUORESCENT FIXTURES, THE REQUIRED ILLUMINATION OF 10FC CAN BE MAINTAINED WITH A REDUCED POWER CONSUMPTION OF

94 FIXTURES × 2 LAMPS/FIXTURE × 9 W/LAMP	=	1692 W
94 FIXTURES × 1 BALLAST/FIXTURE × 6.5 W/BALLAST	=	611 W
		2303 W

- BASE ON 3640 HRS* OF OPERATION, ANNUALLY, THE ENERGY SAVINGS WILL BE:

$$\frac{3640\ \text{HRS}}{\text{YR}} \times (18{,}000\text{W} - 2303\text{W}) \times \frac{3.413\ \text{BTU}}{\text{W}\cdot\text{HR}} \times \frac{\text{MMBTU}}{10^6\ \text{BTU}} = 195\ \text{MMBTU/YR}$$

* SEE ECO E7

- ESTIMATED CONSTRUCTION COST

1. DEMOLITION OF EXISTING:
   2 HRS/FIXTURE × 60 FIXTURES × DM 50/HR = DM 6000
2. INSTALLATION OF NEW FIXTURES (FROM MEANS ELECTRICAL ESTIMATING GUIDE)
   94 FIXTURES × DM 650 /FIXTURE = 61,100

DM 67,100

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO E4-A

PROJECT TITLE: Convert to Fluorescent Lighting FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 6 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1.	INVESTMENT COSTS:			
A.	CONSTRUCTION COST	DM 67,100		
B.	SIOH	DM 3,666		
C.	DESIGN COST	DM 3,666		
D.	TOTAL COST (1A+1B+1C)	DM 68,432		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 74,432

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.02	195.0	DM 7,998.9	11.59**	DM 92,707.2
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		195.0	DM 7,999		DM 92,707

3.	NON ENERGY SAVINGS (+) OR COST (-):			
A.	ANNUAL RECURRING (+/-)	DM 0		
	(1) DISCOUNT FACTOR (TABLE A)		0	
	(2) DISCOUNTED SAVINGS/COST (3A X 3A1)			DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 9.3 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 92,707

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.24

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.15 %

Baker Engineers

S.O. No. 20098-45-3RM

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

VILSECK ECO E4B — Sheet No. 1 of ____

CONVERT TO FLUORESCENT LIGHTING — Drawing No. ____

Computed by CEM — Checked By ____ — Date 6 MAY 1993

- THERE ARE "S" TYPE FIXTURES IN THE EXISTING, NON-KITCHEN SPACES OF BUILDING 603. THIS DOES NOT INCLUDE THOSE "S" TYPE FIXTURES IN THE DINING ROOMS, WHICH WOULD BE REPLACED BY THE RECOMMENDATIONS OF ECO E4A. THE BULBS IN THESE FIXTURES SHOULD BE REPLACED WITH SCREW-IN TYPE FLUORESCENT REPLACEMENT BULBS.

- EXISTING WATTAGE:

  28 FIXTURES × 150 W/FIXTURE = 4200 WATTS

- PROPOSED WATTAGE

  28 FIXTURES × 36 W/FIXTURE = 1008 WATTS

- BASED ON 3640* HRS OF OPERATION, ANNUALLY, THE ESTIMATED ENERGY SAVINGS WILL BE:

$$\frac{3640\ HRS}{YR} \times (4200W - 1008W) \times \frac{3.413\ BTU}{W-HRS} \times \frac{MMBTU}{10^6\ BTU} = 39.6\ MMBTU$$

- ESTIMATED COST

  28 LAMPS × DM 40 / LAMP = DM 1120

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO E4-B

PROJECT TITLE: Convert to Fluorescent Lighting FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 6 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 1,120		
B.	SIOH	DM 67		
C.	DESIGN COST	DM 67		
D.	TOTAL COST (1A+1B+1C)	DM 1,254		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 1,254

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.02	39.6	DM 1,624.4	11.59**	DM 18,826.7
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		39.6	DM 1,624		DM 18,827

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 0.77 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 18,827

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 15.01

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 19.08 %

ECO E7

VILSECK

LIGHTING FIXTURE CONVERSION

Baker Engineers

S.O. No. 20098-45-32M

Subject: GRAFENWÖHR / VILSECK ENERGY AUDIT

VILSECK ECO E7 Sheet No. 1 of

LIGHTING FIXTURE CONVERSION Drawing No.

Computed by CEM Checked By Date 4 MAY 1993

FROM GERMANN CONSULT FAX OF 2 MARCH, 1993

- WITHOUT REDUCING THE LIGHTING LEVEL WITHIN BUILDING 603, THE NUMBER OF 36W LAMPS IN THE LIGHTING SYSTEM CAN BE REDUCED FROM 370 LAMPS TO 326 LAMPS* BY REPLACING THE EXISTING FLUORESCENT LAMP BALLASTS WITH ELECTRONIC BALLASTS.

- WITH CONVENTIONAL BALLASTS, THE CONNECTED LOAD IS:

  $$370 \text{ LAMPS} \times 0.049 \text{ KW/LAMP} = 18.13 \text{ KW}$$

- WITH ELECTRONIC BALLASTS, THE CONNECTED LOAD WILL BE:

  $$326 \text{ LAMPS} \times 0.036 \text{ KW/LAMP} = 11.74 \text{ KW}$$

  SO THE SAVINGS WILL BE $18.13 - 11.74 = 6.39$ KW

- BASED ON 3640* HRS OF OPERATION, ANNUALLY, THE ENERGY SAVINGS WILL BE:

  $$\frac{3640 \text{ HRS}}{\text{YR.}} \times 6.39 \text{ KW} \times \frac{3413 \text{ BTU}}{\text{KW-HR}} \times \frac{\text{MMBTU}}{10^6 \text{ BTU}} = 79.38 \text{ MMBTU}$$

- ESTIMATED CONSTRUCTION COST:

  $$326 \text{ LAMPS} \times \text{DM } 650/\text{LAMP} = \text{DM } 211{,}900$$

* SEE VILSECK ECO E14 FOR DEVELOPMENT OF OPERATING HOURS FOR DINING SPACES

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO E7

PROJECT TITLE: Lighting Fixture Conversion FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 4 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 211,900				
B.	SIOH	DM 12,714				
C.	DESIGN COST	DM 12,714				
D.	TOTAL COST (1A+1B+1C)	DM 237,328				
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0			
F.	PUBLIC UTILITY COMPANY REBATE		DM 0			
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 237,328		

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.02	79.4	DM 3,257	11.59**	DM 37,748.5
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		79.4	DM 3,257		DM 37,748

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

APPENDIX F

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 72.9 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 37,748

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.16

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -5.13 %

ECO E10

VILSECK

DIMMING HARDWARE FOR LIGHTING FIXTURES

Baker Engineers

S.O. No. 20098-45-32M

Subject: GRAFENWÖHR/VILSECK ENERGY AUDIT

VILSECK ECO E10 — Sheet No. 1 of

DIMMER HARDWARE FOR LIGHTING FIXTURES — Drawing No.

Computed by CEM — Checked By — Date 4 MAY 1992

- FROM GEARMAN CONSULTS CALCULATIONS: "EXTERIOR LIGHTING WILL BE CONTROLLED BY INSTALLATION OF DAWN/DUSK CONTROLLERS (PHOTOCELLS) AND TIMER-CONTROLLERS." THEREFORE, THIS ECO IS ACTUALLY A COMBINATION OF ECO'S E10, E11 AND E12. THE SUGGESTED CONTROL SCHEME IS TAKEN FROM USACERL TECHNICAL REPORT E-90/07, DATED MAY 1990. QUOTING FROM PAGE 205, "ONE DIMMING SCENARIO FOR ARMY INSTALLATIONS IS TO HAVE EXTERIOR LIGHTING AT FULL POWER FROM DARK UNTIL 2300 AND AT 55% POWER (45% LIGHT OUTPUT) THEREAFTER."

- EXISTING LIGHTING = 343 WATTS
- EXTERIOR LIGHTING WILL BE REDUCED BY 45% FROM 2300 HRS TO DAWN: THIS WILL REDUCE POWER CONSUMPTION, ON AVERAGE, 5½ HRS/NIGHT

  SO TOTAL ENERGY SAVINGS WILL BE:

$$\frac{365\ \text{DAYS}}{\text{YEAR}} \times \frac{5.5\ \text{HRS}}{\text{DAY}} \times (45\%)(343\ \text{WATTS}) \times \frac{3.413\ \text{BTU}}{\text{W-HR}} \times \frac{\text{MMBTU}}{10^6\ \text{BTU}} = 1.06\ \text{MMBTU/YR}$$

- ESTIMATED CONSTRUCTION COST:

DAWN/DUSK CONTROLLER	= DM	246.-
TIMER-CONTROLLER	= DM	272.-
DIMMER	= DM	40.-
INSTALLATION	= DM	550.-
	DM	1108.-

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO E10

PROJECT TITLE: Dimmer Hardware for Lighting Fixtures FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 4 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 1,108		
B.	SIOH	DM 66		
C.	DESIGN COST	DM 66		
D.	TOTAL COST (1A+1B+1C)	DM 1,240		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 1,240

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

ENERGY SOURCE		COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.02	1.06	DM 43.5	11.59**	DM 503.9
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		1.06	DM 43.5		DM 509.3

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 28.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 509

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.41

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -0.53 %

ECO E14

VILSECK

PHOTOELECTRIC CONTROLS FOR

INTERIOR LIGHTING FIXTURES

Baker Engineers

S.O. No. 70098-45-32M

Subject: Grafenwöhr / Vilseck Energy Audit

Vilseck ECO E14 Sheet No. 1 of

Photoelectric Controls for Interior Lights Drawing No.

Computed by CEV Checked By Date 5 May 1993

- From Robert A. Rundquist's article "Daylighting Controls: Orphan of HVAC Design" in the November 1991 ASHRAE Journal, "A window letting in a fair amount of daylight.... (with).... a dimming-to-30%-power lighting control, one might find a 40% annual lighting savings." The basis for Mr. Rundquist's analysis is a typical office building with photoelectric controlled dimmers modulating the lighting in a 15' wide strip around the building perimeter.

- The Dining Areas of Building 603 operates with the lights on for the following hours

	MON, TUES, WED, FRI	THURS	SAT, SUN
BREAKFAST	0630-0945	0430-0730	0730-1030
LUNCH	1100-1400	1130-1430	1100-1600
DINNER	1630-1930	1530-1830	1530-1830
TOTAL HRS LIGHTS ARE TURNED ON	9.25 HRS	9 HRS	9 HRS

This chart assumes that lights are turned on 1/2 hour before meals and turned off 1 hr after meals

- Annual hrs of operation $= 52\text{wks}\left[(4\times9.25)+(1\times9)+(2\times9)\right]$
$= 3640\text{ HRS/YR}$

Baker Engineers

S.O. No. 20078-45-BCM

Subject: Grafenwöhr / Vilseck Energy Audit

Vilseck ECO E.4 — Sheet No. 2 of

Photoelectric Control of Interior Lighting — Drawing No.

Computed by CEM — Checked By — Date 5 May 1993

- Assume that the cove lighting in the two Dining Areas is put under photocell/dimmer control. There are 23 - "J" fixtures in each Dining Area light cove

46 Fixtures × 36 watts/fixture = 1656 watts
46 Ballasts × 13 watts/ballast = 598 watts

Total = 2254 watts

- Assuming that the 45% savings projected in the Lundquist article is liberal, use a 35% estimate of savings for this project.

- Estimated energy savings:

$$\frac{3640\ HRS}{YR} \times (35\% \times 2254\ WATTS) \times \frac{3.413\ BTU}{WATT\text{-}HR} \times \frac{MMBTU}{10^6\ BTU} = 9.80\ MMBTU/YR$$

- Estimated Construction Cost:

Photoelectric cell controller	2 @ DM 246	=	DM 492
Dimmer	2 @ DM 40	=	80
Electronic Ballasts	46 @ DM 75	=	3450
Installation	8 ckts @ DM 50 each	=	400
			4422

APPENDIX F

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONVERSATION INVESTMENT PROGRAM (ECIP)

LOCATION: Vilseck, Germany REGION NO. 5 PROJECT NO ECO E14

PROJECT TITLE: Photoelectric Controls for Interior Lights FISCAL YR 93

DISCRETE PORTION NAME:

ANALYSIS DATE: 5 May 93 ECONOMIC LIFE: 20 PREPARER Marstiller

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST	DM 4,422		
B.	SIOH	DM 265		
C.	DESIGN COST	DM 265		
D.	TOTAL COST (1A+1B+1C)	DM 4,952		
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		DM 0	
F.	PUBLIC UTILITY COMPANY REBATE		DM 0	
G.	TOTAL INVESTMENT (1D-1E-1F)			DM 4,952

2. ENERGY SAVINGS (+) / COST (-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS 10/92

	ENERGY SOURCE	COST DM/MBTU(1)	SAVINGS* MBTU/YR(2)	ANNUAL DM SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS (5)
A.	ELEC	DM 41.02	9.80	DM 402.0	11.59**	DM 4,659.1
B.	DIST	DM		DM		DM
C.	RESID	DM		DM		DM
D.	NG	DM		DM		DM
E.	PPG	DM		DM		DM
F.	COAL	DM		DM		DM
G.	SOLAR	DM		DM		DM
H.	GEOTH	DM		DM		DM
I.	BIOMA	DM		DM		DM
J.	REFUS	DM		DM		DM
K.	WIND	DM		DM		DM
L.	OTHER	DM		DM		DM
M.	DEMAND SAVINGS			DM		DM
N.	TOTAL		9.8	DM 402		DM 4,659

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-) DM 0

(1) DISCOUNT FACTOR (TABLE A) 0

(2) DISCOUNTED SAVINGS/COST (3A X 3A1) DM 0

* ON THIS FORM MBTU = 10^6 BTU'S

** DISCOUNT FACTOR FOR ELECTRICITY; REGION 5; 20 YEARS

B. NON RECURRING SAVINGS (+) OR COST (-)

	ITEM	SAVINGS (+) COST (-) (1)	YEAR OF OCCUR. (2)	DISCOUNT FACTOR (3)	DISCOUNTED SAVINGS (+) COST (-) (4)
a.		DM			DM 0
b.		DM			DM 0
c.		DM			DM 0
d.	TOTAL	DM			DM 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4): DM 0

4. SIMPLE PAYBACK 1G/(2N3 + 3A + (3Bd1/ECONOMIC LIFE)): 12.32 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5 + 3C): DM 4,659

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.94

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 3.68 %

APPENDIX G

SITE UTILITY ANALYSIS REPORT

Translation of Gehrmann's Report faxed 28 MAY 93

U.S. Army
Grafenwöhr
GC - Project No. 4246

Energy Study
May 1992
Page 1

Review of Electricity Supply Contract for the Locations Grafenwöhr and Vilseck

1. **Supplier:**

Energieversorgung Ostbayern AG Regensburg (OBAG)

2. **Type and Amounts of Electricity Supply**

Nominal Voltage: 20,000V
Nominal Frequency: 50 HZ
Services:

	Connected Service	Effective Demand
Grafenwöhr	6300 KVA	5000 KW
Vilseck	6300 KVA	5500 KW

Powerfactor = 0.9

3. **Connection Facility**

3.1 Grafenwöhr

20 KV Switching Station at Grafenwöhr Transformer Facility

3.2 Vilseck

20 KV Switching Station - Vilseck

4. Provisions for Metering

4.1 Grafenwöhr

Metering is done on the 20,000 volt side at the Grafenwöhr Switching Station.

The following OBAG-owned metering equipment is used:

2	single rate 4-conductor Real Use Contact Meters
2	single rate 4-conductor Reactive Use Contact Meters
1	Two-Rate Real Use Totalizer
1	Average Value Code Printer
1	Schwitching Clock for 15 Minute Release
1	"Ripple" Control Receiver
6	Current Transformers
6	Voltage Transformers

4.2 Vilseck

Metering is done on the 20,000 volt side at the Vilseck switching Station (formerly at the Sorghof 4 Transformer Station, Heringnahe 2).

The following OBAG-owned metering equipment is used.

2	single rate 4-conductor Real Use Contact Meters
2	single rate 4-conductor Reactive Use Contact Meters
1	Two-Rate Real Use Totalizer
1	Two-Rate Reactive use Totalizer
1	Average Value Code Printer
1	Schwitching Clock for 15 Minute Release
1	"Ripple" Control Receiver
6	Current Transformers
6	Voltage Transformers

5. Electricity Price

Electricity-Price for energy is composed of:

5.1 Annual service price for electrical demand in KVA

5.2 Energy prices for:

5.2.1 Effective power during HT periods in KWh

5.2.2 Effective power during NT periods in KWh

5.2.3 Excess Reactive Power in Kvarh

5.3 Charges for the above listed metering equipment:

As of 1-1-90 the following rates are in effect:

For 5.1	Annual Service Rate		Contract	Base
	The annual demand rates	DM/KVA	230.40	130.00

For 5.2 Energy Rates

5.2.1 The HT effective power rates for HT power supplied during the calendar year in DPf/kwh

for the first 1,000,000 kwh	11.35	6.85
for the next 10,000,000 kwh	11.05	6.50
for each additional kwh	11.05	5.70

5.2.2 The NT effective power rates for NT power supplied during the calendar year in DPf/kwh

for the first 600,000 kwh	8.90	4.65
for the next 6,000,000 kwh	7.70	4.40
for each additional kwh	8.70	4.10

5.2.3 The reactive power rates for excess reactive power

in DPf/Kvarh	3.60	2.00

For 5.3 Equipment Charges

The monthly charge for metering equipment without special equipment DM 15.00 10.00

6.0 Billing

Electrical power is billed in monthly installments. At the end of each calendar year, a final billing for the services used is rendered as follows:

1. The annual demand rate is applied to that demand which results from the average of the two highest monthly real power demands divided by the average annual power factor.

   The highest monthly service demand is the highest power in one month that is used by the customer during any 15 minute period.

The average annual power factor is calculated from the annual real and reactive power totals delivered by OBAG to the customer.

2. To determine demand billings, each of the two highest monthly real power demands is applied as at least 70% of the respective monthly demand service.

3. If the highest monthly real power service exceeds the associated [monthly] demand service, then the excess real power used over and above the demand service divided by the annual average power factor is billed additionally at 5% of the annual service rate.

HT = High demand period is defined as Mo. - Fri. (incl.)

April through September	6 a.m. - 9 p.m.
October through March	6 a.m. - 10 p.m.
Saturday's all year	6 a.m. - 1 p.m.

LT = Low demand period is all of the remainder including legal holidays in the OBAG service region.

The above contract prices are predicted on drawing power at no less than 0.9 power factor.

7.0 Possible Cost Reductions

7.1 Service Cost

Substantial savings can be attained since the level of service cost is largely determined by the highest real (or effective) power used during any 15 minute period, for example:

If the service peak is lowered by 100 KVA, the annual cost savings would be
100 kva x 230.40 DM/kva = DM 23,040

The installation of energy optimization equipment particularly for resistance-type users in Canteens would lower service peaks and therefore reduce service costs. Energy optimization equipment for use in Canteens costs about DM 50,000.00.

7.2 Power Costs

Power costs consist of:

HT - High Demand Power Price
LT - Low Demand Power Price
Reactive Power Price

Shifting the power use into the low demand period (according to Item 6) would result in savings of 2.40 D. Pfennig/kwh

Annual total usage	Grafenwöhr	24,987,465 kwh
	Vilseck	31,518,960 kwh

If only 5% of this use would be shifted into the low demand period, annual savings of about DM 70,000 would be realized.

7.3 Power Factor

Drawing service at less than 0.9 PF is billed [extra] at 3.60 D. Pfennig/kvarh. Further, the power factor influences the service cost. However, since the mean power factor in 1992 for Grafenwöhr was 0.998 and for Vilseck 0.991, any additional [power factor] correction will be of no significant use.

Translation of Gehrmann's Report faxed 1 JUN 93

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The thermal (heating) supply contracts between the users of the Grafenwöhr Ostlager (East Camp) and Vilseck Südlager (South Camp) on the one hand, and the heating supply contractor Fränkische Gas Liefergesellschaft Bayreuth on the other, have been reviewed based upon the following documents made available to us:

Grafenwöhr East Camp

Final Billings for the Year 1992
Special Long-Distance Thermal Heating Contract
Valid as of 1 JAN 68 (change in Contract Administrator)

and

South Camp Vilseck

Final Billings for the Year 1992
Billing for Heating Delivery of 5 NOV 92

Based on the calculations done, there is a difference of the thermal price rates between the [above] recipients of about 18%, with Vilseck being more expensive than Grafenwöhr by that difference.

Then, under Item 1.4 of the Grafenwöhr Contract we were struck by the statement that the anticipated daily demand is 420 MWh.

This [anticipated] daily demand is in no way even approached by any of the highest loads in January/February 1992. According to billings on hand the daily demand for January was 212 MWh and for February 234 MWh.

It is unlikely that peak demands of 420 MWh occur, and even if they did, then that figure should not be used as a daily average.

Further, the stated annual volume of 54,000 MWh is also an anticipated assumption, while actual volume according to the billing of 46,197.40 MWh is in fact substantially lower.

One may assume that the amounts stated in the contract were developed to arrive at basic annual rates, prior to the start of actual deliveries, with the result of having substantially overstated the 10-year cost determinations.

For Grafenwöhr, this difference between originally anticipated and actually delivered annual volume is approximately +15%. For Vilseck it is only +3%.

With respect to labor costs, it is noted that, based on the Price Adjustment Clause (Attachment 1), the basic rates differ by DM 6.00/MWh between the two contracts. [However], one may assume that the conditions underlying the labor cost calculations should be the same for both users, thus requiring a justification for the 6.0 DM/MWh difference charged. With an annual volume of about 76,000 MWh this results in an additional cost of DM 450,000.00/year for Vilseck. A similar situation also exists concerning the annual demand charge.

[Thus] it is absolutely essential to re-negotiate the heating supply contracts, particularly with respect to base loads and charges according actually experienced deliveries.

It is also important to watch that short-term peak demands are not applied as long-term loads when setting the basis for rate calculations.

The above determinations are based on the reference documents that were made available (see

preceding page). The 11/5/92 billing for Vilseck includes 1/12 each of the annual demand charge, labor charge, and basic charge. It could not be determined, in what way the variable service and labor pricing reflect actually delivered quantities. Based on the listing (Attachment 2a and b) we may assume that there is a flat (or lump sum billing every 3 months without regard to actually delivered quantities, with adjustments in October (for Grafenwöhr) and in September (for Vilseck).

In general, [it is recommended to] rework the contracts between supplier and customer, [particularly] with respect to the bases used to calculate base amounts such as for annual base price and quantity KWh-based rates for the annual demand as well as the quantity MWH-based rates for labor.

APPENDIX H

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